S0300-A6-MAN-020

0910-LP-103-2763 **REVISION 1**

U.S. NAVY SALVAGE MANUAL VOLUME 2 POL OFFLOADING

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SUPERSEDES: NAVSEA S0300-A6-MAN-050 - 31 JANUARY 1991

PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND

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FOREWORD

This volume is the second in a series of four related publications that make up the *U.S. Navy Salvage Manual*. The family collectively replaces the three volumes of the *U.S. Navy Salvage Manual* issued between 1968 and 1973 and collectively replaces the six volumes of the *U.S. Navy Salvage Manual* issued between 1989 and 1993.

Each volume in the series addresses a particular aspect of salvage with the primary purpose to provide practical information of immediate use to Navy salvors in the field. The secondary purpose is to provide an educational vehicle for learning the technical and practical aspects of our business before applying them to the difficult venue of salvage. These are not cookbooks; they are guidance. Each salvage operation is unique; salvors must use imagination, intellect, and experience to expand the basic information and apply it to a particular situation.

The increasing importance of preventing pollution at sea and the large quantities of oil carried in ships has made emergency petroleum transfers an important part of salvage operations. Because of the nature of the material being transferred, petroleum operations are inherently dangerous. This volume describes procedures for removing oil from the fuel systems of casualties and for the special and complex task of removal of cargo oil from tankers and replenishment ships. Salvors must be aware that the latter is not a routine matter of "flanging up and pumping." Salvage transfers require extensive planning, a high level of technical competence, and good seamanship by salvors.

Calculations contained in the examples can be accomplished in the classroom or the field with a hand-held calculator. A basic knowledge of fundamental engineering information contained in *U.S. Navy Salvage Manual, Volume 1 (Strandings, Harbor Clearance, and Afloat Salvage)* is prerequisite for many sections of this volume. Appendices containing technical data on petroleum transfer equipment and transfer check lists complement the text.

Keep these manuals close. Study the material when possible and be familiar with the contents.

M. M. MATTHEWS
Director of Ocean Engineering
Supervisor of Salvage and Diving

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STANDARD NAVY SYNTAX SUMMARY

Since this manual will form the technical basis of many subsequent instructions or directives, it utilizes the standard Navy syntax as pertains to permissive, advisory, and mandatory language. This is done to facilitate the use of the information provided herein as a reference for issuing Fleet Directives. The concept of word usage and intended meaning which has been adhered to in preparing this manual is as follows:

> "Shall" has been used only when application of a procedure is mandatory.
>
> "Should" has been used only when application of a procedure is recommended.
>
> "May" and "need not" have been used only when application of a procedure is discretionary.
>
> "Will" has been used only to indicate futurity; never to indicate any degree of requirement for application of a procedure.

The usage of other words has been checked against other standard nautical and naval terminology references.

CHAPTER 1
INTRODUCTION

1-1 CONTENTS OF THIS VOLUME.

- Ship's fuel and cargo oil systems.
- Operations planning and preparation.
- Salvage offload of non-cargo oils.
- Petroleum cargoes emergency transfer operations.
- Salvage petroleum offload for submerged vessels.

These chapters describe techniques that have proven successful in the emergency transfer of petroleum products from ships under many different conditions. Appendices provide technical data for salvors involved in oil transfers, data on transfer equipment, and checklists for emergency petroleum transfers. As do other volumes of the *U.S. Navy Salvage Manual,* this volume draws upon the engineering principles described in *Volume 1*. It supplements those principles with ones specific to the problem of fuel and cargo oil behavior in casualties. Like other volumes, this volume is not a complete guide to solving the problems of emergency transfer of petroleum products. Most of the techniques that have been employed in the past have been improvised by the salvors on the scene to fit the conditions of the job. In devising solutions to problems as they occur in the field, salvors are limited only by their imagination and grasp of basic engineering and seamanship.

1-2 INTRODUCTION.

Every powered ship carries petroleum products as fuel and lubricants for its machinery, or as cargo. When a ship becomes a casualty, the potential for release of polluting oil increases greatly. Reducing the risk of release or minimizing the quantity of released oil is of primary importance in casualties. Chapter 3 addresses how pollution prevention may take precedence over action to salvage the ship. When ships are actual or constructive total losses, governments may require removal or destruction of petroleum products whether the ship is to be abandoned or the wreck removed. Environmental protection is such a sensitive issue that well-intentioned authorities may lose sight of the hazards to the ship in their efforts to prevent pollution. Salvors must be professionals in dealing with emergency situations; they have the responsibility of ensuring a balance between salvage action and environmental protection.

1-3 HISTORICAL PERSPECTIVE.

Salvors, recognizing both the pollution potential and the economic value of petroleum products, have recovered them from casualties since before World War II, but it is only in comparatively recent years that the removal of the pollution hazard has become of paramount importance in salvage operations. Because of increasing sensitivity to the environment, removal of a potential source of pollution may be the primary reason for undertaking a salvage operation that would otherwise be bypassed. In commercial salvage, the importance of pollution has been recognized by modification of standard form salvage contracts requiring salvors to prevent pollution and rewarding those who are especially effective.

In U.S. waters, federal law assigns the Coast Guard a major role in casualty response operations, including those involving naval vessels, when the threat of oil discharge or other pollution is present. The Coast Guard’s Federal On-Scene Coordinator (FOSC) is empowered to assume direct control of salvage operations when he determines the action of the owner to be inadequate, untimely, or both to prevent pollution. The Navy, as the Government's salvor, may undertake salvage and pollution control operations at the request of, or on behalf of, the Coast Guard or by other federal agencies or foreign governments via the State department. In doing so, or in responding to requests for salvage of commercial vessels, Navy salvors may encounter crude oils and other products that they would not encounter in Navy ships. Other governments maintain similar strict control over pollution aspects of salvage operations in their waters. Close liaison with government agencies with pollution control responsibilities is always necessary. These agencies may require that they approve salvage and offloading plans.

Salvors' ability to remove petroleum products from casualties efficiently has grown with environmental sensitivity. Specialized equipment for pumping petroleum products has been developed or adapted from other industries. Specialized products alone are insufficient to ensure safe, successful emergency transfer operations. Salvors must be knowledgeable in the safety requirements of tanker salvage operations and in handling large quantities of petroleum products. The problem of dealing with petroleum products in salvage is large, real, and present in every operation. It can be expected to remain in the forefront.

1-4 OIL REMOVAL AS A SALVAGE ACTION.

The removal of oil from a casualty must be an integral part of the salvage operation with full consideration given the effect of the weight removal on the casualty. The effects of weight removal on stability are discussed throughout *U.S. Navy Salvage Manual, Volume 1 (Strandings, Harbor Clearance, and Afloat Salvage),* S0300-A6-MAN-010. The most serious situation occurs when the ship is stranded. Removal of oil will reduce the ground reaction and may allow the ship to broach or move into a more dangerous position if the weight is not properly compensated. All risks related to the removal of oil to reduce pollution hazards should be fully understood and discussed with authorities, including the potential that the premature removal of oil may create greater problems than it solves.

1-5 PETROLEUM PRODUCTS.

Petroleum products carried at sea are divided into three classes:

- Crude oils.
- Refined products.
- Residual products.

Crude oils are carried primarily by commercial tankers between oil production sites and refineries. An almost infinite variety of petroleum products are carried as cargo at sea. Some heavy crudes contain so much wax or asphalt that they are very viscous and may require heating before pumping, while light crudes are similar to refined products, such as diesel fuel. Often, crude oils are mixed before shipping to improve handling or to provide a specification required by the refinery. Crude oils also have different levels of toxic and corrosive sulfur compounds. For instance, sweet crudes have low sulfur concentrations, while the highly corrosive sour crudes have more than 10 parts per million of hydrogen sulfide.

Though refined products are carried as fuels and lubricants in all ships, ship fuels and lubricants are only a small portion of the refined petroleum products carried at sea. Other products include benzene, naphtha, gasolines, diesel fuels, heating oils, jet fuels, and many others of widely varying characteristics. These refined products are broken down into subcategories including:

- Gasolines – any manufactured from natural gas (natural, motor, and aviation).
- Napthas and benzenes.
- Light distillates (kerosene and kerosene-based jet fuels).

Some of these products have characteristics that make them particularly hazardous to handle. Though crude oils are heavy and viscous and may therefore be thought not to be particularly volatile, all crudes include some portion of light ends (gasoline, kerosene, naptha, etc.), and present serious fire, explosive, and health hazards. Salvors should not attempt the emergency transfer of refined products without seeking professional expertise that can identify the hazards of the particular product and provide advice on how the hazards can be overcome. The Supervisor of Salvage can arrange for on-site expertise or consultation. The U.S. Coast Guard's Hazards Response Information System (CHRIS) can be accessed online at http://www.uscg.mil/hq/nsfweb/foscr/ASTFOSCRSeminar/References/CHRISManualIntro.pdf and used effectively if basic information about the product is known, such as:

- Chemical name.
- Color.
- Odor.
- IMO-UN number.
- DOT ID number.

Residual products, including heavy fuel oils, lubricating greases, heavy lubricating oils, and asphalts, make up about 17.5 percent of the POL carried by seagoing vessels. The majority are heavy fuel oils such as #6 fuel oil (Bunker C). Most of the heavy oils that make up this category are so viscous that special pumps, or heating or pipeline lubrication techniques must be used to pump the oil.

Physically, petroleum products have many different appearances and wide ranges of color and weight. Although most petroleum products are lighter than water, temperature and agitation can cause them to sink or emulsify. Petroleum products present a variety of hazards, some of them specific to the particular product. Chapter 2 of the *U.S. Navy Salvage Manual, Volume 3 (Oil Spill Response)*, S0300-A6-MAN-030 discusses the hazards of petroleum and non-petroleum cargo.

1-5.1 Definitions. There are descriptive terms for the characteristics of petroleum products that influence behavior during handling. Knowing these terms leads to a better understanding of the mechanics of POL operations allowing the user to anticipate and avoid some of the problems that occur during transfer operations.

Viscosity – A measure of the resistance to flow (internal friction) of the product at a particular temperature. Kinematic viscosity is expressed in centistokes (cSt). The viscosity of water at 68 degrees Fahrenheit is approximately 1.00 cSt. Highly viscous liquids are thicker and flow more slowly than less viscous liquids. Oil viscosity is a function of its temperature. Another type of viscosity, absolute viscosity, is measured in poise. The absolute viscosity of water at 32 degrees Fahrenheit is 1.8086 centipoise. The two viscosities are related by:

Kinematic viscosity = Absolute viscosity/density

Both kinematic and absolute viscosities are used in petroleum operations. Saybolt Universal Second (SSU) and Saybolt Furol Second (SSF) are units of kinematic viscosity given by readings on a Saybolt viscometer and are used primarily in marine petroleum operations. The Saybolt Universal viscometer is used for liquids having viscosities below 1,000 centistokes. The Saybolt Furol viscometer is used for more viscous fuel oils ("furol" is an acronym for fuel and road oils). In both cases, the reading is the time, in seconds, for 60 milliliters of a sample to flow through the device. The Furol viscosity readings are roughly 1/10 the Universal readings. For liquids whose viscosity exceeds 50 centistokes at 37.8 °C (100 °F), one SSU is approximately 0.2158 centistokes or 0.2158 mm2/s. For very viscous liquids (viscosity exceeding 500 centistokes) at 50 °C (122 °F), one SSF is approximately 2.120 centistokes or 2.120 mm2/s. Exact equations were published in 1996 by the American Society for Testing and Materials (ASTM practice D2161). The Saybolt seconds are considered obsolete, but they have been used traditionally in the petroleum industry and are common in technical articles. Figure 1-1 provides a means for converting between Saybolt Seconds and centistokes with sufficient accuracy for salvage work.

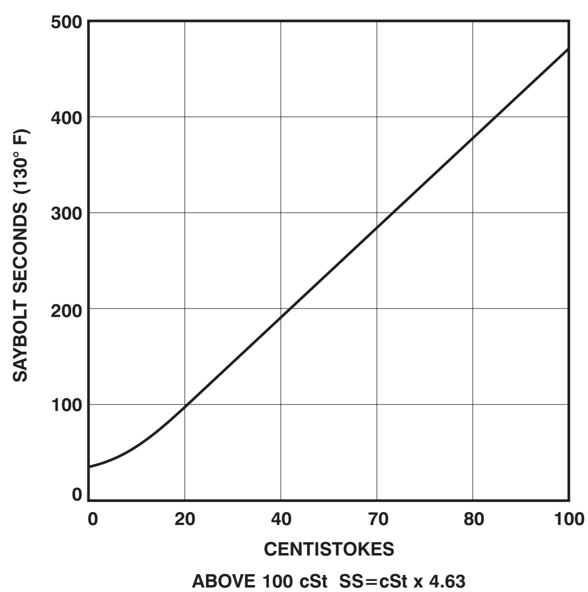


Figure 1-1. Approximate Conversion Between Saybolt Seconds and Centistokes.

Shipboard tank heating systems maintain oil temperature and viscosity to ensure the oil can be easily pumped. As the result of a ship casualty, marine cargo pumps may fail if the oil cools and viscosity significantly increases. SUPSALV maintains submersible, centrifugal, and screw pumps that can pump fluids up to about 10,000 cSt viscosity. The ESSM system can provide portable steam generators and water injection systems for pumping heavy oil. See Appendix C for details.

Specific Gravity – A measure of the weight per unit volume of a material compared to the weight of the same volume of water at a certain temperature, usually 60 degrees Fahrenheit. A specific gravity less than 1.0 means that the material is lighter than and floats on fresh water. Some bunker oils will have a specific gravity close to or slightly above seawater. Such oil can either float or sink, depending on the water temperature. The specific gravity of seawater is 1.025 and must be taken into account in some oil-water calculations. Specific gravity is also expressed as American Petroleum Institute (API) gravities (degrees API). API gravities are based on the arbitrary assignment of a gravity of 10 degrees to fresh water. Liquids with higher gravities are lighter than water; those with lower API gravities are heavier than water. Conversion between specific gravity and degrees API is described below. Table 1-1 gives specific and API gravities and weight-volume data for water and representative petroleum products.

Conversion from specific gravity to Degrees API is by:

$$\text{Degreees API}=\left(\frac{141.5}{\text{specific gravity at }60\,^{\circ}\text{F}}\right)-131.5$$

Conversion from Degrees API to specific gravity is by:

$$\text{Specific gravity at }60\,^{\circ}\text{F} = \frac{141.5}{\text{Degreees API} + 131.5}$$

EXAMPLE 1-1
CONVERSION BETWEEN SPECIFIC AND API GRAVITIES

a. A particular petroleum product has a specific gravity of 0.86 at 60 ℉. What API gravity (Degrees API) does this specific gravity correspond to?

$$\text{Degreees API}=\left(\frac{141.5}{\text{specific gravity at }60\,^{\circ}\text{F}}\right)-131.5$$

$$\text{Degreees API}=\left(\frac{141.5}{.86}\right)-131.5$$

$$\text{Degreees API}=164.53-131.5$$

$$\text{Degreees API}=33.03$$

b. A particular oil has an API gravity (Degrees API) of 50 at 60 ℉. What specific gravity does this correspond t o?

$$\text{Specific gravity at }60\,^{\circ}\text{F} = \frac{141.5}{\text{Degreees API} + 131.5}$$

$$\text{Specific gravity at }60\,^{\circ}\text{F} = \frac{141.5}{50 + 131.5}$$

$$\text{Specific gravity at }60\,^{\circ}\text{F} = \frac{141.5}{181.5}$$

$$\text{Specific gravity at }60\,^{\circ}\text{F} = 0.78$$

Table 1-1. Specific Gravity, API Gravity and Weight of Representative Petroleum Products.

Product	Specific Gravity	API Gravity	lb/gal	bbl/ton
Fresh Water	1.000	10.00	8.33	6.30
Asphalt	1.040	4.61	8.67	6.06
Benzol	0.882	28.87	7.36	7.14
Crude Oil, Heavy	0.983	12.40	8.19	6.41
Crude Oil, Light	0.797	46.03	6.64	7.90
Diesel Oil, Distillates	0.845	36.05	7.05	7.46
Gasoline, Aviation	0.708	68.40	5.90	8.90
Gasoline, Motor	0.741	59.41	6.17	8.50
Gasoline, Natural	0.741	59.41	6.17	8.50
Grease	1.000	10.00	8.33	6.30
Kerosene, Jet fuel	0.813	42.57	6.76	7.75
Lubricating Oils	0.900	25.72	7.50	7.00
Mineral Spirits	0.731	62.11	6.10	8.62
Paraffin Wax	0.801	45.26	6.67	7.87
Petrolatum	0.801	45.26	6.67	7.87
Petroleum Coke	1.145	-7.97	9.55	5.50

Volatility – A measure of the evaporation rate. Light oils—those with low specific gravities—are usually the most volatile.

Flash Point – The lowest temperature at which enough vapors are released to create a flammable mixture of gas and air near the surface of the liquid. Materials with flash points greater than 150 degrees Fahrenheit are practically nonvolatile.

Autoignition Point – The temperature at which a heated POL vapor ignites spontaneously and sustains combustion, although no spark or flame is present.

Pour Point – The lowest temperature at which a petroleum product flows. Because lowering temperatures increases viscosity and decreases volatility, heating may be required to raise residual products and some crude oil temperatures to the pour point for pumping.

Flammability – A relative measure of how easily a product burns. The U.S. Coast Guard has divided POL products into two broad categories: *flammable*—products with flash points below 80 degrees Fahrenheit, and *combustible*—products with flash points above 80 degrees Fahrenheit. Products are subdivided into five grades: A, B, and C are flammable; D and E are combustible. Grade A, B, and C products are defined by their Reid Vapor Pressure—the pressure generated by vapor when the product is placed in a sealed container and heated to 100 degrees Fahrenheit. Grade D and E products are defined by their flash points. Both Grade D and E products are relatively safe to handle. Table 1-2 gives the specifics of flammability classification.

Table 1-2. Flammability Classification of Petroleum Products.

Class	Flash Point	Reid Vapor Pressure
A (flammable)	80 °F or below	14 psi or above
B (flammable)	80 °F or below	Between 8.5 and 14 psi
C (flammable)	80 °F or below	Below 8.5 psi
D (combustible)	80 to 150 °F	NA
E (combustible)	Above 150 °F	NA

Explosive Range – The range of hydrocarbon gas concentrations in air that is capable of being ignited and of burning. The range is bounded by upper and lower explosive limits. Concentrations of vapor lower than the Lower Explosive Limit (LEL) are too low in hydrocarbon vapor (lean) to burn and concentrations above the Upper Explosive Limit (UEL) are too high in hydrocarbon vapor (rich) to burn. The explosive range is usually between one and six percent of hydrocarbon vapor in air but varies with the petroleum product. Small quantities of volatile POL products can produce vapor concentrations within the explosive range. The explosive range is affected by the oxygen content of the atmosphere; explosive atmospheres cannot form if the oxygen content is 11 percent or less by volume. Figure 1-2 illustrates the explosive range as a function of oxygen content in a hydrocarbon vapor atmosphere.

Toxicity – All POL products are toxic to humans to some extent. Toxic effects range from contact dermatitis to almost immediate unconsciousness and death. The characteristics and safety issues of the products to be handled must be known before undertaking emergency transfer operations. U.S. and international safety regulations require Material Safety Data Sheets (MSDS) to be on each vessel for oil and chemicals carried onboard. MSDS's contain information on the characteristics and toxicity of POL products. MSDS sheets for the cargo and other oils should be available onboard, from the shipper, or available on-line.

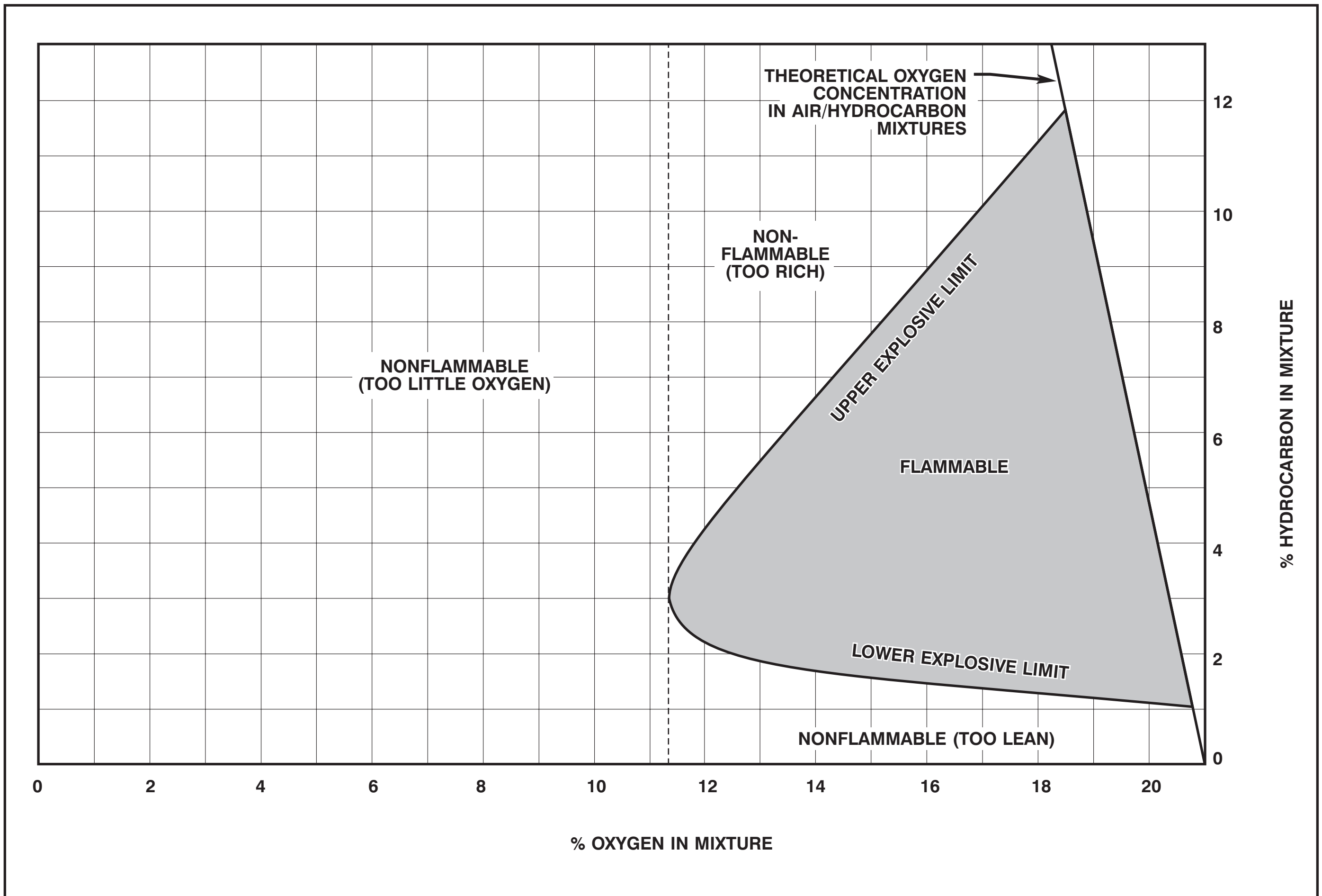


Figure 1-2. Explosive Range.

1-5.2 Relationships of Petroleum Characteristics. The density, specific and API gravities, and volumes of petroleum products vary with temperature. In petroleum computations, it is standard practice to make all calculations at the standard temperature of 60 degrees Fahrenheit. Tables of gravity changes are usually found aboard ships that carry oil cargoes and in the API Manual of Petroleum Measurement Standards. Appendix B contains detailed information for converting:

- Observed degrees API to degrees API at 60 degrees Fahrenheit.
- Degrees API to specific gravity between 26.5 and 48.9 degrees API.
- Volumes at 60 degrees Fahrenheit occupied by unit volumes at temperatures between 0 and 150 degrees Fahrenheit for liquids with API gravities between 30 and 49 degrees.
- Graphical methods for converting outside the ranges presented in tabular form.

1-6 OIL-WATER HYDROSTATICS.

An understanding of how oil in ruptured tanks behaves is basic to correct handling of oil in casualties. The weight of the petroleum product, as indicated by specific gravity, determines the mechanism by which spills occur. POL with a specific gravity less than 1.00 is lighter than pure water and floats on the surface of water. If a tank containing oil is holed, either the oil spills from the tank or water enters the tank until the hydrostatic pressures of the water outside the hole and of the oil inside balance. When balance is achieved there is no flow.

Damaged deep tanks on ships will not necessarily spill all their contents. If a deep tank containing oil less dense than the surrounding water is holed below the waterline, oil flows out until the oil within the tank reaches a level where the sea pressure and oil pressure balance as shown in Figure 1-3. The depth of oil above the hole is deeper than the depth of water outside the tank because of the oil's lower density. Some additional oil will flow out as the relative heights of the oil-water interface and the upper edge of the hole fluctuate because of passing waves or vessel rolling, establishing a shallow *water bottom* beneath the oil. For ships stranded in tidal areas, additional oil will flow out as the water level falls below that at the time of the casualty. Little oil will be spilled on subsequent tide cycles, unless subsequent low tides are lower than the previously experienced lowest water level. It was estimated that in the *EXXON VALDEZ* casualty, approximately half the oil spilled flowed out of the damaged tanks in the first 20 minutes after the grounding, while most of the remaining oil spillage occurred over the next 24 hours as the tide rose and fell.

It is not always necessary to empty a damaged tank completely to stop oil leakage. Deepening or establishing water bottoms provides a buffer that can prevent further discharge of liquids lighter than water. As a practical matter, a water bottom has been established when the cargo pumps begin to draw water instead of oil. The thickness of the water bottom can be increased by drawing oil from the top of the tanks with portable pumps, allowing water to flow in through the breached plating. In the initial stages of the incident, salvors or spill responders should attempt to create or increase water bottoms in damaged tanks, especially if lightering capacity is limited and several tanks are leaking. Water bottoms should be deep enough to ensure that several feet of water remains beneath the oil at the lowest anticipated tide. As operations continue, water bottoms can be systematically increased until the tanks are completely discharged of oil. Chapters 4 and 5 of this volume discuss the use of water bottoms and methods to remove liquids from damaged vessels.

The effectiveness of water bottoms is limited for water soluble liquids or liquids with a specific gravity very near one. Water bottoms cannot be created at all under liquids with specific gravities greater than one. Many bulk chemicals fall into this category, as well as some crude oils and bunker fuels.

$$P_w = P_o$$

where:

P_W = hydrostatic pressure of the water outside the hull in pounds per square inch (psi)

P_o = hydrostatic pressure of the oil inside the hull in psi

The hydrostatic pressure of a fluid is proportional to the specific gravity of the fluid and its depth so that at hydrostatic equilibrium:

$$(SG_w)(D_w) = (SG_o)(D_o)$$

where:

SG = the specific gravity of the water in which the ship is floating *(SG_W)* or of the petroleum product in the tank *(SG_o)*

D = the depth of the water (D_W), or of the petroleum product (D_o)

For seawater:

$$D_o = (1.025)\left(\frac{D_w}{SG_o}\right)$$

EXAMPLE 1-2
OIL-WATER HYDROSTATICS

a. A tank on a tanker is 60 feet deep and contains oil with a specific gravity of 0.86. The tanker draws 42 feet. What depth of oil in the tank balances the hydrostatic pressure on the bottom of the ship?

$$D_o = (1.025)\left(\frac{D_w}{SG_o}\right)$$

$$D_o = (1.025)\left(\frac{42}{0.86}\right)$$

$$D_o = 50.06 \text{ feet}$$

b. The same tank contains oil with a specific gravity of 1.05. What depth of oil in the tank balances the hydrostatic pressure on the bottom of the ship?

$$D_o = (1.025)\left(\frac{D_w}{SG_o}\right)$$

$$D_o = (1.025)\left(\frac{42}{1.05}\right)$$

$$D_o = 41.00 \text{ feet}$$

If the hydrostatic pressure of the oil inside the tank is greater than hydrostatic pressure of the sea outside the tank, the contents of the tank flows out. If the hydrostatic pressure of the oil inside the tank is less than the hydrostatic pressure of the sea outside the tank, seawater flows into the tank. If the hydrostatic pressure inside and outside the tank is the same, there is no flow into or out of the tank.

If the tank described in Example 1-2(a) contains more than 50.06 feet of oil, oil flows from the tank until the pressure balances. If the tank contains less than 50.06 feet of oil, seawater flows into the tank until the pressure balances. Figure 1-3 illustrates this principle.

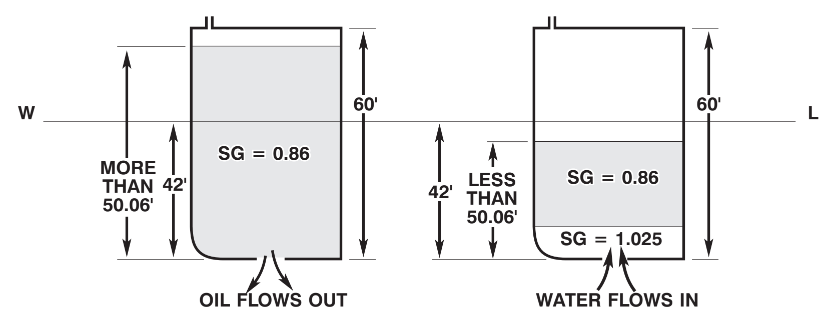


Figure 1-3. Oil-Water Hydrostatics.

Tanks that are filled to well above the waterline can be expected to spill oil into the sea when ruptured. Oil in damaged double-bottom and other tanks low in the ship, where the depth and hydrostatic pressure are low, is forced up sounding tubes, overflows, and vents by entering seawater and may spill over into other tanks, out into compartments, and onto decks. Brief discharges, or belches, are common but sustained flows occur only where a submerged tank is holed in the bottom.

When a ship with ruptured tanks is stranded and cannot rise and fall with the tide, the fluid level within the tanks rises or falls to balance the changing hydrostatic pressure outside the ship. If a ship strands at high water and damages her tanks, several events may take place:

- Oil in filled deep tanks spills until the hydrostatic pressure is balanced.
- Oil from deep tanks spills as the tide falls and the external hydrostatic pressure decreases.
- Oil from tanks low in the ship is forced up sounding tubes, overflows, and vents by entering seawater.
- Oil from tanks low in the ship may spill as the tide falls if the hydrostatic pressure outside the ship falls low enough.
- Seawater enters the ship to keep the hydrostatic pressure balanced as the tide rises.
- If subsequent tides are lower, additional spillage may occur.

Petroleum products with specific gravities less than one float on floodwater forming a layer of water, or *water bottom*, in the bottom of a ruptured tank. The water bottom is an excellent tool for salvors as it prevents discharge of oil through the holed bottom while allowing salvors to pump off the floating oil.

In a tank with a water bottom, the total pressure at the bottom of the tank is the sum of the pressure of the oil and the pressure of the water bottom.

$$P_t = (0.434)(SG_o)(D_o) + (0.445)(D_w)$$

where P_t is pressure at the bottom of the tank, in psi, and D_o and D_W are expressed in feet.

Pressure at the bottom of the tank is also equal to:

$$P_t = (0.445)(T)$$

where T is the draft, in feet, at the tank.

EXAMPLE 1-3
DEPTH OF WATER BOTTOM

The tanker described in Example 1-2 has a draft of 42 feet. She has holed a tank that has settled out and is in balance with 12 feet of oil with a specific gravity of 0.86 in the tank. What is the depth of the water bottom?

$$P_t = (0.434)(SG_o)(D_o) + (0.445)(D_w)$$

$$(0.445)(T)_t = (0.434)(SG_o)(D_o) + (0.445)(D_w)$$

$$(0.445)(42)_t = (0.434)(0.86)(0.975) + (0.445)(D_w)$$

$$D_w = 42 - (0.86)(0.975)(12)$$

$$D_w = 42 - 10.06$$

$$D_w = 31.94 \text{ feet}$$

The water bottom in the tank is 31.94 feet deep and the total depth of liquid in the tank is 43.94 feet.

When ships sink, water entering tanks through holes, sounding tubes, vents, or overflows displaces oil so that it flows upward and out of the ship. Oil may be trapped and unable to rise to the surface if the ship is sharply heeled or capsized.

POL with a specific gravity greater than the water in which the ship is floating behaves like any other heavy cargo. If a tank containing a liquid with a specific gravity greater than water is holed, the liquid flows out of the tank until the tank is empty or the liquid level is below the hole. The heavy liquid can be expected to settle to the seafloor and may move with the current.

CHAPTER 2
SHIPS' FUEL AND CARGO OIL SYSTEMS

2-1 INTRODUCTION.

All ships have fuel oil systems that store oils and deliver these oils to the boilers, engines, or machinery where they are consumed. Tankers and oilers carry oil as cargo; large combatants and replenishment ships carry cargo oils for delivery to other ships. Systems consisting of pumps, piping, valves, and supporting equipment receive both fuels and petroleum cargoes, move them from tank to tank, and offload them from the ship. These systems differ in detail from ship to ship, but share common principles. Salvors who understand these principles can build on them to develop means to transfer petroleum fuels and cargo in an emergency or a casualty.

There are two principle types of POL handling or transfer systems in ships: the fuel system found in every ship, and the cargo transfer system in oilers, tankers, and some major combatants. Smaller systems handle lubricating and hydraulic oils, and on some ships, fuel for embarked aircraft or vehicles. This chapter describes the general principles that apply to these systems; it does not describe any system in detail. Information for warships is based on U.S. Navy requirements; that for commercial vessels is based on the requirements of the American Bureau of Shipping and the U.S. Coast Guard. Foreign ships differ in detail. Salvors preparing for emergency transfer of fuels and other oils must determine the details of the casualty's fuel and cargo systems.

2-2 FUEL OIL SYSTEMS.

2-2.1 Commercial Vessel Fuel Systems. The fuel oil system in most commercial vessels has two parts: *the fill and transfer system* and the *service system*. The fill and transfer system has the tanks, piping, and pumps for loading, storing, and transferring fuel internally. The service system is made up of the daily service or day tanks, piping, and pumps that provide fuel directly to the engines or boilers. Usually, fuel must be removed from both systems of a casualty. Salvors must know what to look for in fuel oil systems and how fittings and equipment may be integrated into defueling operations.

Commercial vessels, particularly those with large, low-speed diesel engines, often carry more than one grade of oil. A light oil such as Diesel Fuel, Marine (DFM), provides greater engine flexibility while maneuvering, while a heavier oil like Bunker C is burned while steaming steadily in the open sea.

2-2.1.1 Tanks. Often, commercial vessel fuel oil tanks are in double bottoms because this space is relatively inaccessible, not desirable for cargo, and the fuel puts weight low in the ship. Double-bottom tanks may not have enough space for all the fuel, or they may be reserved for clean ballast to maintain stability. There are no double-bottom fuel tanks under the machinery spaces. Deep tanks, as well as double-bottom tanks, may be provided for fuel oil. Deep fuel oil tanks are usually symmetrical about the centerline for damaged stability. In certain ship types, such as roll-on/roll-off ships and warehouse ships, with cargo spaces relatively high in the ship, deep tanks carry fuel while double bottoms contain clean ballast. Fuel in tankers is normally in large combination storage and settling tanks in the machinery space and large storage tanks forward of the cargo area. The forward fuel oil tanks are usually called *foredeeps*.

All tanks require at least one vent pipe; tanks with large surface areas have more than one vent. One of the vents is always at the highest point in the tank. The vent pipes are at least 2.5 inches (61 mm) in diameter, lead to weather, extend at least 8 feet above the main deck, and end in a gooseneck with a ball check valve and a flame screen for adequate drainage. Vents have a minimum slope of 30 degrees with the horizontal wherever possible for adequate drainage. There are no requirements for straightness or minimum radius of curvature in vent lines. Vent lines may terminate some distance from the tanks they serve and may have sharp bends. Vent headers, though not common, are permitted.

Tanks have sounding tubes that lead as straight as possible to the bottom of the tanks. The tubes are at least 1.5 inches (38 mm) outside diameter and 1.25 inches (31 mm) inside diameter. Sounding tubes may be perforated along their lengths to ensure the liquid level is the same inside and outside the tube. Gate valves are fitted in sounding tubes with their upper ends below the freeboard deck. Tanks may have automatic gauging systems as well as sounding tubes.

Overflows lead from all tanks to an overflow tank or storage tank with space reserved for overflow oil. Overflows are fitted with alarms and sight flow glasses.

Access into fuel tanks is through manholes with bolted, gasketed covers. In the case of tankers, the access to forward and aft main storage tanks is through an expansion trunk similar to cargo tank accesses. Figure 2-1 is a schematic of a typical fuel tank and its fittings.

If the ship burns heavy, very viscous fuels, tanks have steam heating coils.

2-2.1.2 Fill and Transfer Systems. Fuel comes aboard at the deck fueling station, then flows by gravity through a fueling manifold in the machinery spaces to the storage tanks via one or two transfer mains. Most commercial vessel fuel systems have a high and low suction in each tank. The high suction is for normal operations and delivers relatively clean fuel. The low suction is for stripping; sediment, water, scale, and impurities in the fuel settle to the bottom of the tank for removal through the low suction. Piping in the transfer system is steel and may be either flanged or welded; valves are usually gate valves.

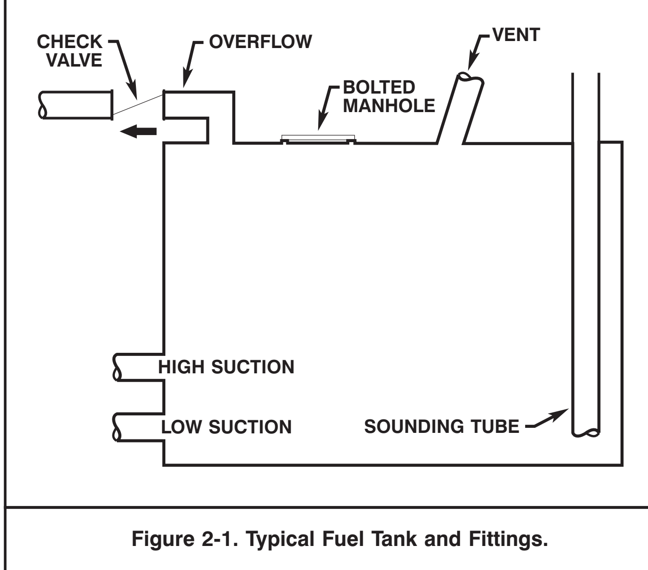


Figure 2-1. Typical Fuel Tank and Fittings.

Fuel is transferred with the fuel oil transfer pump from the storage tanks to settling tanks. The settling tanks are normally above the double bottoms and just forward of the machinery spaces. Water and sediment that has not previously separated from the fuel in the storage tanks settles out in these tanks. Figure 2-2 is a simplified schematic of a commercial vessel fuel oil fill and transfer system.

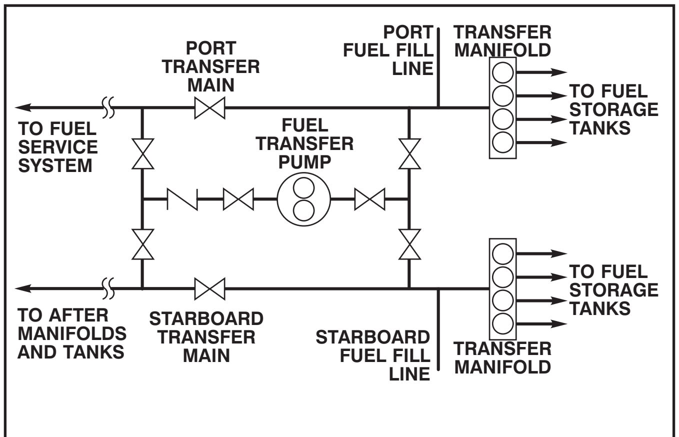


Figure 2-2. Simplified Fuel Transfer System Schematic.

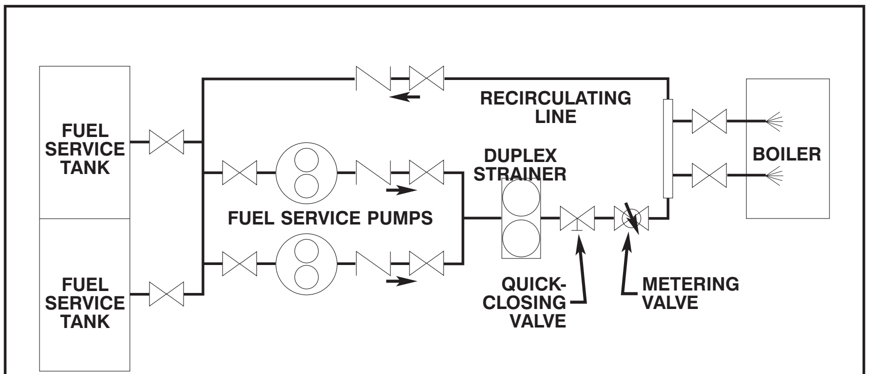


Figure 2-3A. Steam Ship Fuel Service System.

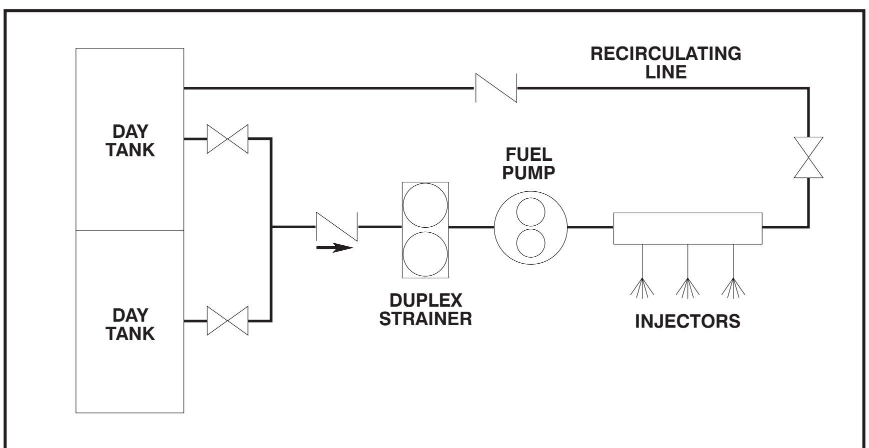


Figure 2-3B. Diesel Engine Fuel Service System.

The fuel oil filling and transfer system provides a means for routing the discharge of the fuel oil transfer pump to the deck connection so that the ship may be defueled with installed equipment.

The configuration of fuel oil systems varies with the complexity of the ship and what the system must do. There is no standard configuration. The fuel oil filling and transfer system is of particular interest to salvors because the system is the preferred means of defueling casualties. Salvors should obtain plans of the fuel oil transfer system. In the absence of plans, the configuration of the fuel oil transfer system can be deduced from the general arrangement, tracing out accessible piping, and studying valves and manifolds.

2-2.1.3 Fuel Oil Service Systems. In steam ships, fuel oil service pumps usually take suction on the settling tanks and discharge directly to the boilers through fuel oil heaters. The system in diesel and gas turbine-driven ships is somewhat different. In these ships, fuel from the settling tanks is centrifuged and pumped into a day tank. The engine fuel pumps take suction directly on the day tank and deliver fuel to the engines. Settling tank suction valves and fuel oil service pumps have remotely operated shutoffs. Fuel oil service piping is steel. Figure 2-3A is a schematic of a steamship fuel oil service system; Figure 2-3B is that of a diesel-powered ship.

2-2.2 Warship Fuel Systems. Warship fuel systems have the same function and purpose as commercial vessel systems—to receive fuel oil, store it, and deliver it to the engines or boilers. The systems also provide a means of pumping the oil off the ship. Fuel systems in warships are tailored to the lighter fuels burned by these ships and have more redundancy and protective features than corresponding systems in commercial vessels. Fuel systems in gas turbine ships are similar in configuration to those in diesel-powered ships.

Warship fuel systems are designed to handle Diesel Fuel, Marine (DFM) MIL-F-16884 (NATO Code F-76), and JP-5 MIL-T-5624 (NATO Code F-44) interchangeably.

2-2.2.1 Tankage. In warships, fuel tanks may be double-bottom tanks, wing tanks, or other tanks integral with the ship's structure. As they are in commercial vessels, the fuel tank arrangement in warships is usually symmetrical about the centerline. Fuel tanks in warships are of the following types:

- Fuel tanks – stow fuel received from the filling and transfer system.
- Fuel or ballast tanks – selectively stow fuel received from the fuel filling or transfer system or seawater ballast from the seawater ballast system.
- Fuel overflow tanks – receive overflow from fuel tanks.
- Fuel service tanks – receive clean fuel from the fuel transfer system for delivery to the fuel service system.
- Auxiliary fuel service tanks – serve diesel generators, auxiliary boilers, and other services.
- Gas turbine emergency JP-5 gravity tanks – stow a reserve supply of fuel for propulsion gas turbine when electrical power is interrupted.
- Contaminated fuel settling tanks – receive discharge from the fuel stripping system.
- Seawater compensated tanks

There are at least two fuel service tanks for each space containing a propulsion boiler, diesel engine or gas turbine. Normally, each tank has space for fuel for 8 hours—6 hours for some gas turbine ships—of full power operation. Auxiliary machinery in the same space may take its fuel from these tanks. Each main propulsion boiler, diesel engine, or gas turbine space also has a contaminated fuel settling tank. There is one fuel service tank for each space with an emergency generator. Auxiliary machinery rooms in combatants have dedicated fuel service tanks, while naval auxiliaries may use main fuel service tanks.

All fuel tanks have a tank level indicating system. Tank level indicating systems are backed up by 1½-inch outside diameter sounding tubes that, whenever possible, have a radius of curvature of 10 feet. Fuel tanks are fitted with vents that terminate on weather decks in a gooseneck with a flame screen. Overflows from fuel tanks have check valves. Access to tanks is through bolted, gasketed manholes.

Some ships have seawater-compensated fuel systems. In these systems, the tank is always full; seawater and fuel replace one another as fuel is consumed or the tank is filled with fuel.

Ships that operate aircraft have tanks dedicated to aircraft fuel. These tanks are constructed in the same way and have the same features as ships' fuel tanks. Amphibious ships that carry motor gasoline have water-compensated tanks surrounded by cofferdams inerted with carbon dioxide.

2-2.2.2 Filling and Transfer Systems. All warships have a pressure-filling system with a riser to the deck connection from the fill main or fill and transfer mains. Separate fill and transfer mains are cross-connected and each fueling station can be segregated from the others.

Warship filling and transfer systems are designed to receive oil at a minimum of 40 psi and distribute it to the tanks. The portion of the system from the deck connection to the tank cutout valves or manifolds may be subject to replenishment ships' cargo pump shutoff pressure. Consequently, these portions of the systems have a 200 psi design pressure. Ships with seawater-compensated fuel systems may have valves with orificed discs that restrict flow into tanks to reduce the possibility of pollution while fueling.

Deck connections are set up for 6- or 7-inch hoses. The connections terminate in a 90-degree elbow, gate valve, and 8-inch drilled flange for connection to the fueling-at-sea nipple or probe. The connection is approximately two feet above the deck. A check valve is installed outboard of the flange.

All transfer pumps connect to the mains that in turn connect to manifolds or cutout valves serving the tanks. Transfer systems on warships are capable of greater isolation than those on commercial vessels. Cutout valves are provided at major bulkheads, in mains between cross- connections, in cross-connections where they join mains, and at each pump suction and discharge.

The transfer system is the primary means for moving oil into or out of the ship and for moving it within the ship. When planning emergency transfers of fuel from the ship, details of the system should be obtained and studied to ascertain how the system may be used in the emergency transfer.

2-2.2.3 Fuel Service Systems. Like commercial vessels, fuel service systems in warships provide fuel from the fuel service tanks to main propulsion or auxiliary machinery. However, warship systems are more complex and more flexible. The exact configuration varies with the type and number of units served by the system. Fuel oil service piping in warships is likely to be high-pressure piping with welded joints throughout.

Of primary interest to salvors tasked with removal of fuel is that the service system can be connected to the transfer system. The connection is usually through a locked valve or a flange with a blind flange installed. Equally important, on ships with a JP-5 system serving aircraft, the JP-5 system can be connected to the fuel oil service system. These connections give salvors a number of options for handling fuels within the ships' piping systems.

2-3 CARGO OIL SYSTEMS.

2-3.1 Tankers. Tankers are commercial vessels or naval auxiliaries with the mission of loading crude oil or petroleum products at a source, transporting it to another point, and offloading it. Navy transport oilers (T-AOT) are relatively small tankers that transport fuels in support of military operations. Tankers carry cargoes with widely varying characteristics. Crude oil is carried most frequently and in the largest ships. Tanker systems are designed to maximize the amount of cargo carried and to make loading and offloading operations efficient. Tanker operations are inherently dangerous because of the volatility and flammability of the cargo. Safety features designed into the ship and tanker safety rules are intended to reduce the hazard of normal operations to acceptable limits.

2-3.1.1 Arrangement. Crude carriers are the most common type of tanker and are the largest of ships. Product carriers rarely exceed 50,000 tons deadweight; some crude carriers are larger than 500,000 tons. Ships between 160,000 tons and 300,000 tons are Very Large Crude Carriers or VLCCs; those exceeding 300,000 tons are Ultra Large Crude Carriers or ULCCs. All modern tankers, both product carriers and crude carriers, conform to a three-part subdivision, with service spaces forward, cargo amidships, and machinery and accommodation aft. In some old commercial tankers and some naval auxiliaries, there is a house with navigating and accommodation spaces amidships.

The forward section of the ship includes peak tanks, chain locker, boatswain's stores, and forecastle. No cargo may be carried in tanks forward of the collision bulkhead. Some ships, most commonly small ones, may have gas-tight spaces for drummed or packaged cargo. There may be a fuel oil tank and a cargo pump room in the forward area. A cofferdam often separates the forward area from the cargo area.

The cargo area amidships is the largest portion of the ship. This area is divided into a number of tanks determined by the type of cargo for which the ship is designed. Crude carriers normally have three tanks across designated by a number—low numbers forward—and P(ort), C(enter), or S(tarboard). Center tanks are of larger capacity than wing tanks. Some wing tanks may be set aside for segregated ballast as a pollution control measure and a defensive measure against collision. There may be a double bottom. Product carriers have more tanks than crude carriers. In most modern tankers, the cargo pump room is at the after end of the cargo area in a space that doubles as a cofferdam between the cargo area and the machinery space. Product carriers and some naval auxiliaries have pump rooms co-located with groups of tanks. If there is no pump room between the cargo area and machinery spaces, there is a cofferdam. Figure 2-4 shows a typical single-hull tanker arrangement.

Double-hull tankers are replacing older single-hull tankers as the result of U.S. and international regulations. Single-hulled tankers will become increasingly rare. In U.S. waters all tankers must be double-hull by 2015. Implementation may occur more quickly in other jurisdictions. The Military Sealift Command (MSC) is phasing-in double-hulled tankers. MSC's T-AOT 1122 class and T-AO 201 class tankers are the first of their double-hull tankers.

Therefore, the salvor will encounter many different vessel designs, ranging from single hulls, double-sides, double-bottoms, protectively located segregated ballast and full double-hulls. It is particularly

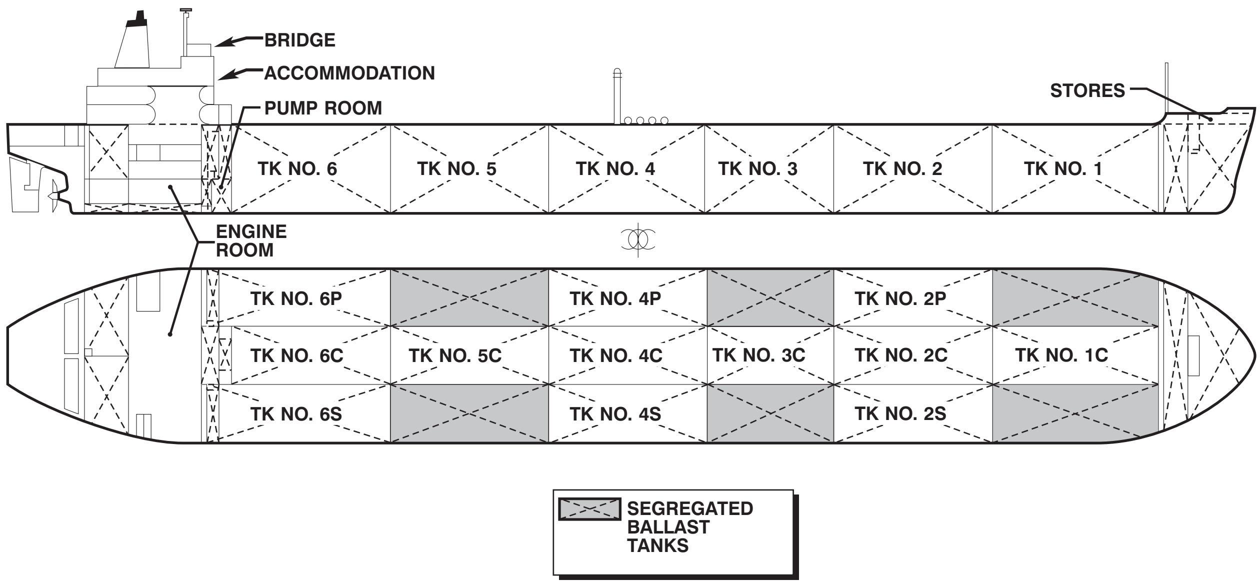


Figure 2-4. Typical Tanker Arrangement.

important to acquire detailed structural and arrangement information in conjunction with an accurate condition survey remain before undertaking any salvage operation.

Further information on double-hull tankers operation and design can be found in the Marine Board report, *Double-Hull Tanker Legislation: An Assessment of the Oil Pollution Act of 1990*. This report discusses issues related to salvage and emergency oil offloading of double-hull ships. These issues include:

Advantages

- Damage to cargo tanks may be more limited in a collision or grounding.
- Lack of internal tank framing, sumps, and smooth tank walls may allow more complete discharge using portable or installed pumps.
- The large number of ballast tanks may provide flexibility in conducting salvage operations.

Disadvantages

- Some designs, particularly those with no center line bulkheads, can become unstable during cargo and ballasting operations.
- Hull structure may have significantly higher hogging moments due to the location of loaded ballast tanks.
- Double-hulls complicate the use of external access techniques (hot tapping) to the cargo tanks.

The hull abaft the cargo area is occupied by the machinery space and tankage. Accommodation and service areas are in the house above the main deck. Navigating spaces are high in the ship, giving watch officers an adequate view forward even when the ship is trimmed by the stern. By law, accommodation and machinery spaces in the most modern tankers are abaft the cargo area and separated from it by a fire-protective bulkhead that does not pass flame or smoke for one hour in a standard fire test. The cargo control room is in the accommodation block, usually on one of the lower levels on the forward side. The officer in charge of loading and discharge operations directs operations from the cargo control room. A typical cargo control room contains:

- Controls for valves and pumps.
- Inert gas system controls and gauges.
- The load computer.
- Stress, draft, and trim indicators.
- Communications equipment.
- Ullage indicators.
- Tank high- and low-level alarms.
- Tank temperature indicators.
- Cargo system pressure indicators.

The cargo control room may have windows facing forward, allowing the Mate conducting the loading and discharge to observe the action on deck and at the manifolds.

The stack is well aft and tall enough to prevent sparks from falling into the cargo area when hazardous operations are in progress. Mooring winches and fittings are located on the forecastle, the stern, and on the main deck in the cargo area.

2-3.1.2 Load Computers. Most tankers have a load computer that calculates the ship's stability, shear, bending moment, draft, and trim for different loading conditions. The load computer is usually in the cargo control room. The Chief Mate is normally the officer most proficient in its operation. Stability and strength calculations are made before and during loading and offloading operations to ensure the ship is stable and that maximum permissible bending moments and shearing forces are not exceeded at any time. There are a wide variety of load computers available; most are tailored to the specific ship. Many load computers provide for both "still water" and "at sea" conditions. They are most suitable for planning transfer sequences when the ship being offloaded is afloat and intact. While some load computers have a grounded ship case, most do not. Few are able to account for reduced section modulus. Load computers often read out in percentages of a stability standard—such as the IMO standard—or of allowable design shear or bending moment rather than absolute values of metacentric height, shear, and bending moment. The percentage values are of little value to salvors who may have to work outside normal limits. Salvors should understand how installed load computers apply to their particular situation. They should be somewhat wary of load computers on stranded ships or ships with hull damage because parameters governing the computer's operation may not fit the existing case.

2-3.1.3 Tank Gauging. The amount of cargo in a tanker is determined by measuring the distance from a reference point to the surface of the fluid, then entering a table for each tank with this distance. The distance is called an *ullage.* Figure 2-5 illustrates ullage in a tank.

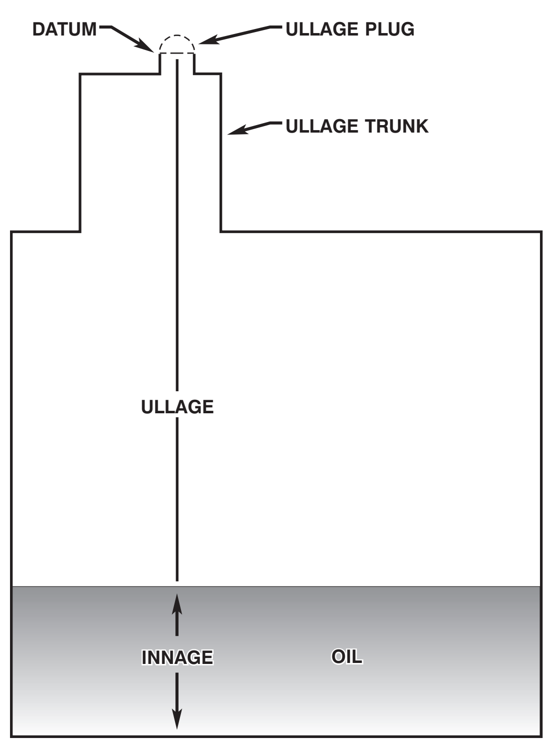


Figure 2-5. Ullage Measurement.

Previously, ullages were taken with stainless steel or linen sounding tapes with special weights on the end. The weight had a small cavity on its bottom that caused it to make a loud pop as it struck the surface of the liquid. Modern tankers and all those fitted with inert gas systems have closed tank systems with automated ullage systems. Automatic ullage systems may be either mechanical or electronic. Most systems transmit ullages to the cargo control room. In some installations, the tank gauging system transmits ullages directly to the load calculating computer.

Tankers fitted with automatic ullage and inert gas systems also have means for taking ullages manually. When ullage openings are opened, personnel should keep their heads well away from the gas coming from the opening and should stand at right angles to the wind. Personnel standing directly upwind of the ullage port may create an eddy of gas that will come back toward them. It is normal practice to relieve the inert gas pressure in a tank by opening it to the vent mast before gauging. Some pressure remains and loose items such as pins, covers, and flame screens may become airborne missile hazards. Ullage openings should be opened slowly until excess inert gas pressure bleeds off.

2-3.1.4 Cargo Pumps and Piping Systems. Cargo is loaded and offloaded through specialized piping systems with dedicated pumps. Information specific to a particular ship is found in detailed piping and pump room diagrams and plans. Plans may usually be obtained from the ship's cargo officer or chief engineer. It is always prudent to find personnel with extensive operating experience with the system and knowledge of alterations or changes that are not shown in the plans or diagrams.

Most modern tankers have up to four horizontal or vertical, multistage centrifugal cargo pumps. The pumps, which may be electrically or steam driven, are sized to offload a full cargo in 12 hours. Pump rooms contain the main cargo pumps and their associated piping valves and fittings. In modern tankers, there is generally a single pump room, most often just forward of the engine room. The pump room can usually be isolated from the rest of the cargo handling system through upper and lower block valves on deck and at the bottom of the pump room respectively.

Because of the potential for leakage of volatile cargo and formation of explosive vapor concentrations, the pump room is ventilated and isolated from sources of ignition. Pump prime movers are normally in the engine room, separated from the pumps they drive by a bulkhead. Pump room ventilators should run continuously during transfer operations. If the pump room ventilation system is inoperative, temporary exhaust systems must be rigged to keep the pump room atmosphere safe. Pump room bilges must be kept free of large accumulations of petroleum. Modern ships have dedicated piping for discharging pump room bilges to slop tanks. In older ships, a slop hose may be rigged from the outlet flange just outside the pump room door.

Deep well pumps—vertical centrifugal pumps with their prime mover on deck and pump end near the bottom of the tank—originally offloaded small tanks on multigrade or specialized ships. These pumps are now comparable in size to conventional main cargo pumps and offload large ships. Deep well pumps eliminate the need for conventional pump rooms, and reduce suction problems, power requirements, and the need for a stripping system.

Reciprocating steam cargo pumps and, occasionally, gear pumps, are found in old tankers.

Tanker cargo systems are basically piped, free flow, or combinations of the two. Piped systems are most common. These systems consist of large—10- to 36-inch diameter—mains with smaller branches into individual tanks. The branches end in suction valves and bell mouths. One cargo pump serves each group of tanks. Figure 2-6 is a diagram of a typical piped system. Mains are cross-connected in the pump room on both suction and discharge sides of the cargo pumps. When loading, cargo is distributed through the suction lines from either cross-connections in the pump rooms or drop lines from the deck discharge lines to the cargo mains. Pump room block valves are closed and the pump room is isolated when cargo is loaded through droplines. Ships carrying a variety of products that must be segregated may have individual drops for individual tanks or groups.

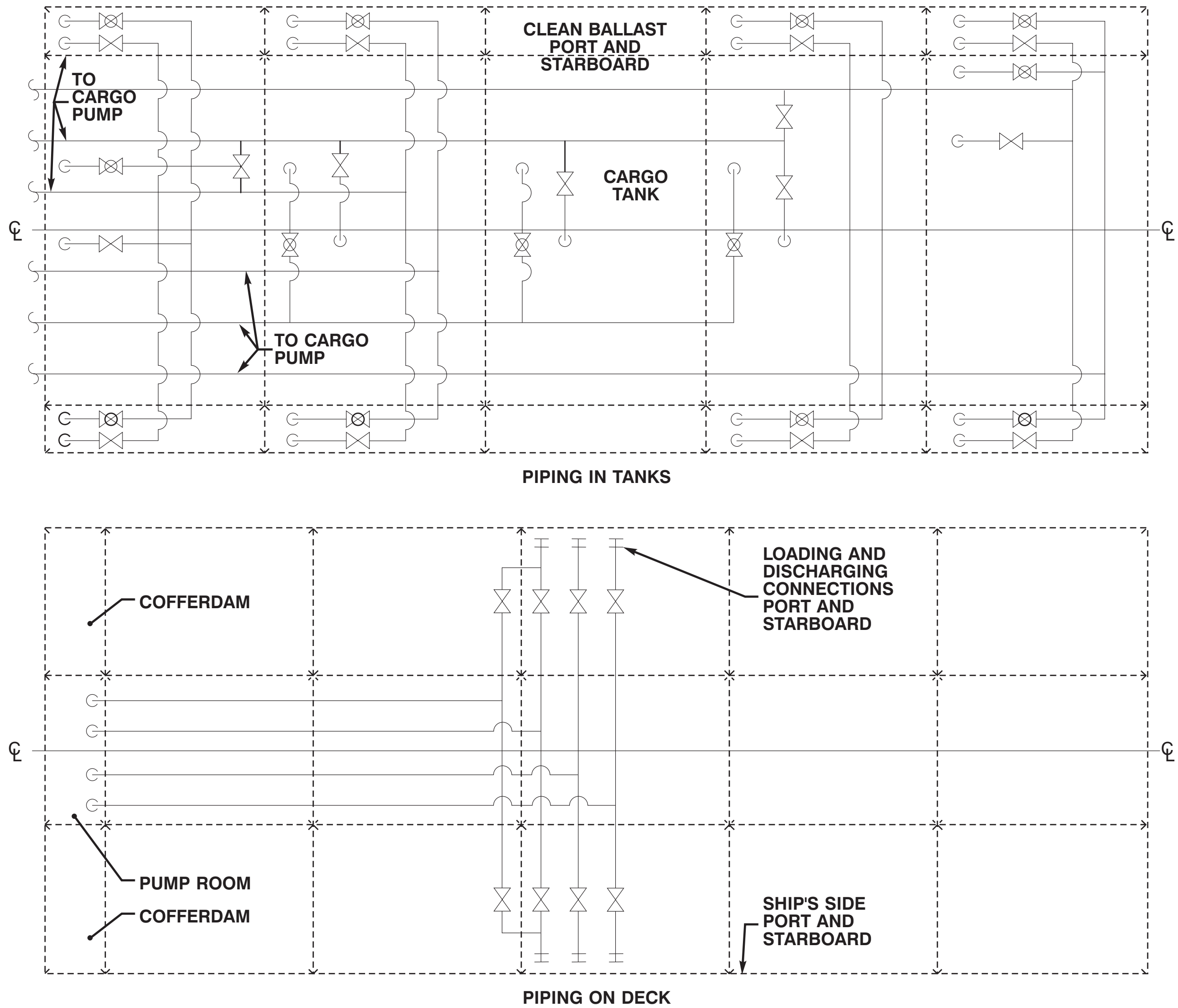


Figure 2-6. Piped Cargo Handling System.

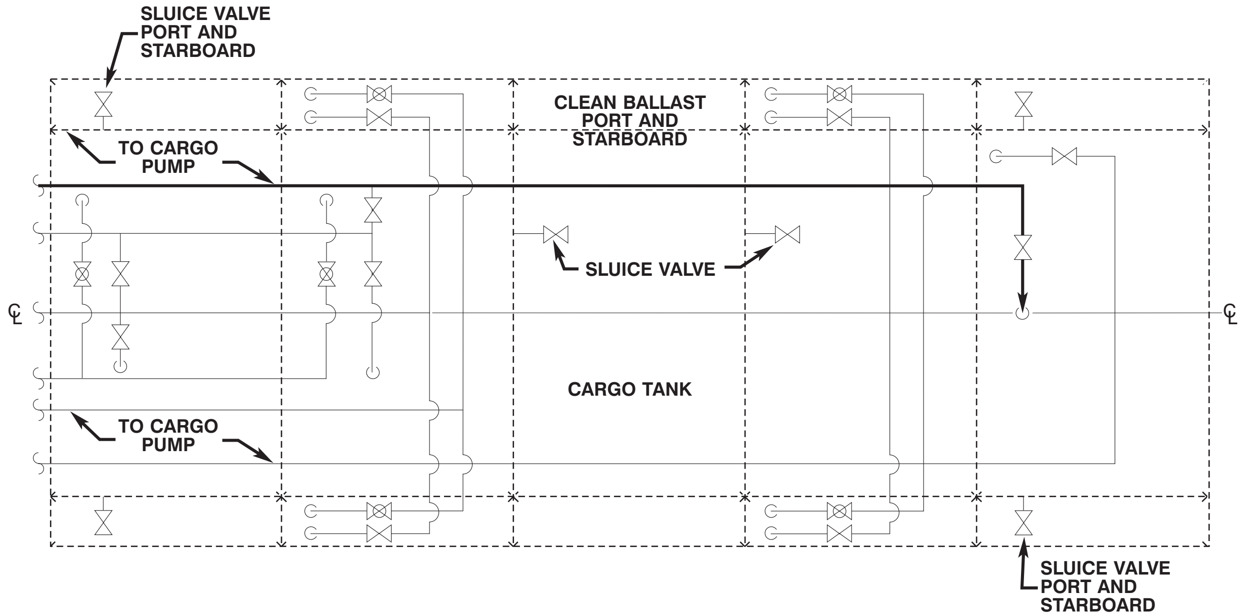


Figure 2-7. Modified Free-flow System - Piping in Tanks.

Full free-flow systems have no piping except suction connections in the after tanks. Individual bulkheads have sluice valves allowing all the cargo to sluice into the after tanks and for pumping. Drop lines for loading are still required. Modified free-flow systems are more practical because they allow better trim control and some cargo flexibility. These systems combine free-flow and piped systems in that they have suction piping to each group of tanks and sluice valves within the tank group. Figure 2-7 illustrates such a system. The duct system, a variation of the modified free-flow system, is found occasionally. Duct systems are a variation of piped systems in which a large rectangular duct replaces the main suction piping. Sluice valves or branch lines route cargo to and from the duct. Only VLCCs and ULCCs have free-flow, combination, or duct systems.

Ships with deep well pumps may have either piped or modified free-flow systems, but piping is simplified. Figure 2-8 is a piping system with sluice valves in a typical deep well pump ship.

Valves are provided on cross-connection lines and on each tank. These are usually butterfly valves, but sometimes may be gate valves. Tank valves are operated from the deck or control room by hydraulic operators on the valves or through reach rods that may be pneumatically, hydraulically, or manually activated. Power operation for valves was introduced because of the difficulty of operating very large valves manually. Some fully automated ships have power assistance for all valves, but it is common to find a combination of power and manually operated valves. Systems are often set up so that valves that can be positioned before starting a transfer operation are manually operated, while those that must be operated during the transfer have power assistance. In most ships, particularly those with manually controlled valves, valves are marked with distinctive, color-coded markings. These markings are ship- and class-specific—even aboard U.S. Navy vessels. Valve designations are often stenciled on the deck or bulkhead next to the valve. Stamped tags with the valve designation may be attached to the valve wheel itself. The valve's function must be understood clearly before a valve is operated.

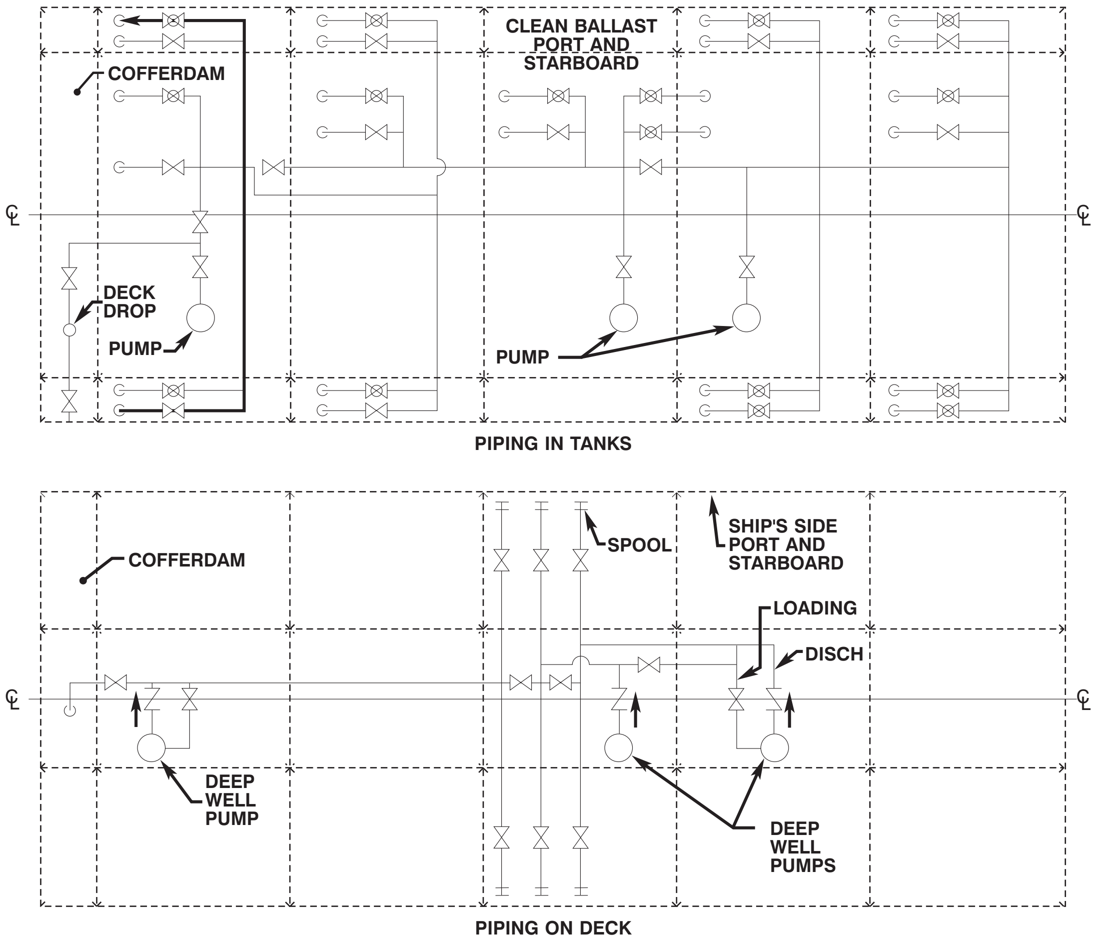


Figure 2-8. Cargo Piping in Deep Well Pump Tanker.

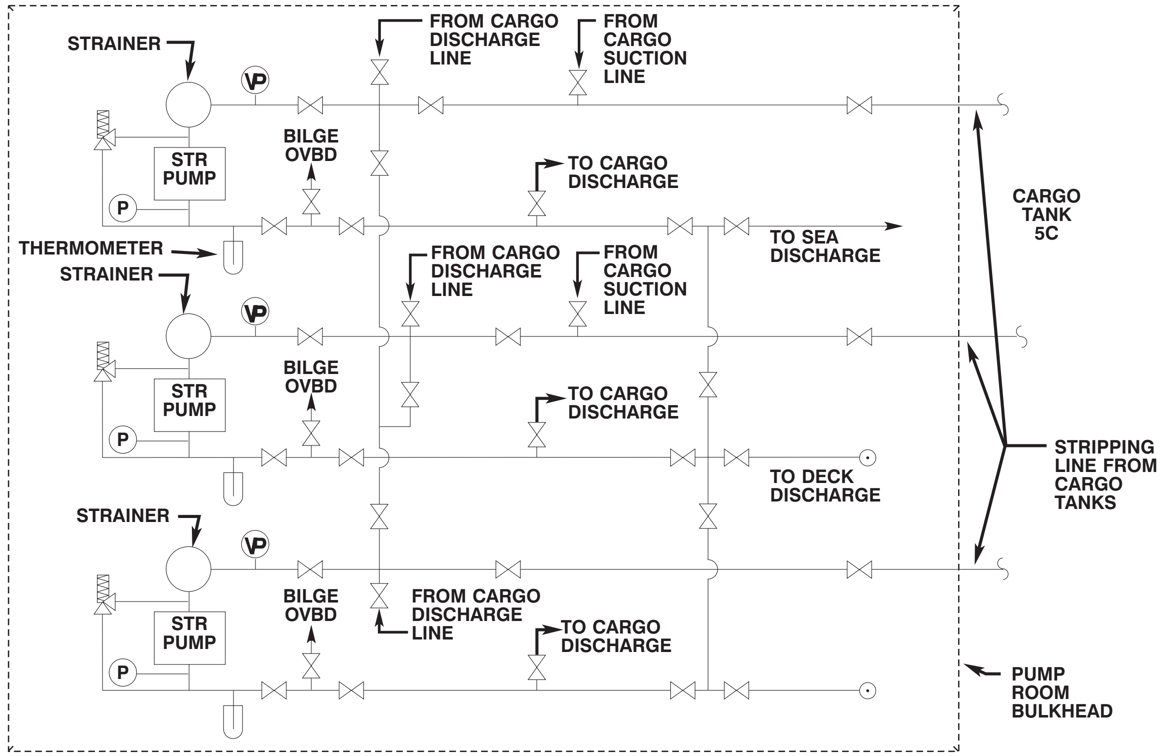


Figure 2-9. Typical Pump Room Stripping System for Piped Tanker.

The cargo manifold is the upper terminal of the cargo piping system. It is a collection of valves and piping, duplicated on the port and starboard sides amidships, that provides the connecting point for transfer hoses or connecting arms. A valve, open only when transferring cargo, controls each transfer connection. There are usually crossover connections between tank groups to provide flexibility and redundancy. Most manifolds have a small drain cock or valve on each line for drawing samples and admitting air for blowing down the manifold and transfer hoses.

Piped, free-flow, and duct systems require stripping systems to remove residual cargo that is beyond the capability of centrifugal main cargo pumps. The stripping system ordinarily consists of small, positive displacement pumps and a separate piping and valve system with relatively small-diameter pipelines. Figure 2-9 illustrates a typical stripping system. On some ships, the system is a small-diameter branch of the main pipeline; tanks are stripped with the main transfer pumps by special pumping techniques. Vacuum pumps that improve the capabilities of the main cargo pumps eliminate the need for a separate stripping system.

Most piping systems are mild steel; some special petroleum products and chemical cargoes require piping of special alloys.

When piping systems have been broken or damaged in a casualty and oil cannot be pumped through them, an alternative means for removing the cargo must be arranged. The most common method is by over-the-top pumping, as discussed in Section 5-4 of this volume.

2-3.1.5 Vents. Vents relieve pressure and prevent formation of a vacuum in tanks that can be structurally damaged by excessive pressure or vacuum. Pressure changes in the tank can occur with ambient temperature or barometric changes or during loading or unloading. The products a tanker carries determines the venting requirements. Ships that carry flammability Grade A products are required to have closed vent systems—others may have standpipes. Ships that may legally have standpipes often have closed systems if they are carrying products that produce noxious fumes. All ships with inert gas systems must have closed vent systems. The largest venting requirement is during loading; vent systems are sized for that service.

The basic closed system consists of a single vertical riser with a flame arrester for each group of tanks. The riser extends at least 13.1 feet above the deck, but is usually much higher. Branch lines connect the single riser with the individual tanks. Branch lines may not have stop valves. Simple standpipes are fitted to each tank, either directly to the tank or to the tank access. Pressure vacuum relief valves—PV valves—are not required on these systems, but are fitted to control vapor emission during the voyage. PV valves maintain the pressure in these systems between a maximum of 3 psi above atmospheric and a minimum of 1 psi below atmospheric. Pressure limits may be narrower for specific systems but always range from a slightly positive pressure to a slight vacuum.

2-3.1.6 PV Valves. PV valves are pressure- and vacuum-actuated mechanical valves that open when the pressure in the tank is a maximum of 3 psig or a minimum of -1 psig. Open valves allow air flow into or out of the tank to preclude excessive pressure or vacuum. PV valves may be on the riser of closed systems or on the individual tanks. On standpipe systems, they are usually on the top of the standpipe. PV valves are fitted with mechanical opening devices so they may be opened manually during transfer operations in ships that are not inerted.

2-3.1.7 <u>Inert Gas Systems</u>. Hydrocarbon gases normally encountered in tankers cannot burn in atmospheres containing less than 11 percent oxygen. To decrease the risk of fires and explosions originating in cargo tanks, the space above the cargo is filled with inert gas. The inert gas lowers the oxygen content of the atmosphere to below the Lower Explosive Limit. While the purpose of an inert gas system is to prevent cargo tank fires or explosions, it may be of assistance in extinguishing fires.

Due to a number of tanker accidents in the mid-1970's, the International Conference on Tanker Safety and Pollution Prevention and the Port and Tanker Safety Act of 1978 required that U.S and foreign vessels have inert gas systems (IGS) in operation while they are in U.S. waters. For U.S. vessels, IGS are required for all crude oil carriers over 20,000 DWT and all product carriers over 40,000 DWT. Foreign tank ships of the same size while operating in U.S. waters must have their IGS in operation

In most inert gas systems, exhaust gas drawn from the boiler or engine is routed through a water scrubber that cools the gas and removes soot and corrosive sulfur products. The gas is then distributed to the tanks by blowers. The inert gas distribution piping system has a water seal on deck to prevent gases from the tanks from flowing back through the system and reaching the engine or boiler. A water-sealed, pressure vacuum breaker provides a means of ventilating the tanks should the ventilation requirements exceed the capacity of the PV valves. In lieu of engine or boiler exhaust, a gas turbine with an afterburner or an independent inert gas generator may produce the inert gas. Figure 2-10 illustrates a typical tanker inert gas system.

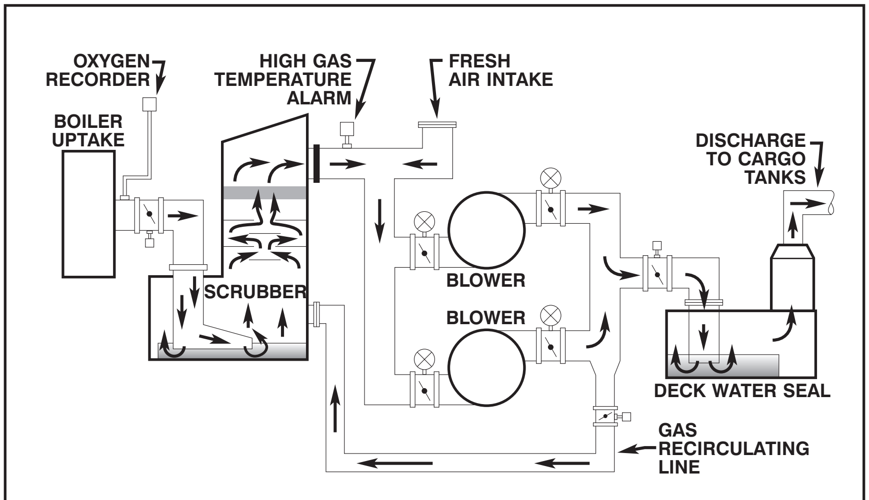


Figure 2-10. Typical Inert Gas System.

The gas delivered to the tanks is mostly nitrogen and carbon dioxide with an oxygen content of less than five percent. The gas can be delivered at a maximum pressure of 3.5 psig. Inert gas is not simply blown into the tank; the tank atmosphere is purged by any one of several methods depending on the details of the system design. The atmosphere of a tank must be changed completely three to five times to lower the oxygen content of an air-filled tank to the accepted standard of eight percent by volume. Eight percent gives a comfortable margin of safety below the point at which gases can burn.

Inert gas systems are in service during both loading and offloading operations. During loading operations, the gases vent to atmosphere, either through the PV valves or bypasses, as oil flows into the tank. Upon completion of loading, tanks are topped off with inert gas to ensure a positive pressure in the tank. During cargo offloading, inert gas must be supplied to the tank to maintain a positive pressure. If the pressure in a tank falls below atmospheric, air is drawn into the tank and the oxygen content of the tank atmosphere is increased. Many modern ships have a control system that shuts down the cargo pumps when pressure falls below atmospheric. Oxygen content of the inert gas should be monitored during offloading, particularly if the inert gas is being produced by a boiler with a low or fluctuating load. Failure of the inert gas system during offloading is a serious casualty. Routine offloading operations should be terminated if the inert gas system fails during offloading. In emergency transfers, it is not always practical to terminate operations for an inert gas system failure. The decision to continue or terminate offloading operations is made by the salvage officer after considering all the circumstances of the casualty and evaluating the risks. In cases of cargo being shifted between tanks or consolidated, it may be practical to minimize venting to the atmosphere by connecting the tanks being loaded and offloaded through the inert gas main.

The presence of inert gas systems in a tanker does not guarantee that the tanks are inerted. When a ship's main engines have been shut down for an extended period, as often happens in casualties, tank inerting may have deteriorated and explosive atmospheres may have developed in the tanks. Salvors should always meter the oxygen content of tank atmospheres with either the installed or portable oxygen analyzers and multigas detectors. Low boiler loads may reduce the supply of gas available to repressurize or reinert tanks. Running steam-driven cargo pumps to circulate oil between tanks may produce additional gas. Extreme care must be taken not to overflow tanks during such an operation.

2-3.1.8 <u>Automatic Transfer Systems</u>. Some tankers have fully automated cargo transfer systems in which the entire transfer operation can be programmed. With few exceptions, the valves in automated transfer systems are butterfly valves operated by hydraulic rams at the valve. The systems are simple to operate, but are hydraulically complex. There are no manual backups or operating modes for the individual valves in the tanks.

It may be possible in a casualty to replace the hydraulic power unit, or place a portable hydraulic unit with compatible hydraulic fluid aboard and connect it into the control piping. Small hand pumps at local control stations may operate the valves in the local mode. If piping to the valve is broken inside the tank, the system cannot be restored and the tank must be offloaded over-the-top. Automation is an asset to normal transfers, but casualties to the automation can complicate emergency transfer operations.

2-3.2 <u>Replenishment Ships</u>. Replenishment ships are naval vessels (AO, AOE, AOR) or naval auxiliaries (T-AO) that carry oil cargoes for transfer to other ships while underway. These ships operate in direct support of at sea task forces, normally carrying only DFM and JP-5 in bulk. Replenishment ships' cargo systems vary from those in tankers by being more compartmented and more flexible. Major combatants carry fuel in bulk and have systems for delivering it to other ships while underway.

DFM and JP-5 cargo tanks are capable of carrying either fuel. Separate tailpipes from the DFM and JP-5 cargo systems are provided for each fuel in each cargo tank. These tailpipes lead directly to the DFM or JP-5 pump room. JP-5 fill, suction, and stripping tailpipes are flanged in the tank so they may be removed and the piping blanked when DFM is carried in JP-5 cargo tanks. The second set of piping in the cargo tanks not only increases the flexibility of the system in normal operations, but also gives salvors additional options for emergency offloading.

Transfer systems in replenishment ships are designed to maintain 100 psi transfer pressure at the deck connections. Portions of the transfer system that can be subject to cargo pump shutoff pressures have a design pressure of 200 psi. However, replenishment ships and some oilers and tankers have two or more pump rooms. On combatants with cargo oil systems, POL transfer pumps are in the general machinery spaces. On naval vessels, piping and pump room diagrams are part of the Engineering Operating Sequence System (EOSS).

2-3.2.1 <u>DFM Cargo Systems in Replenishment Ships</u>. Cargo DFM systems in replenishment ships receive their cargo in bulk from either ships or shore terminals and offload it through replenishment hoses to ships alongside. Cargo piping is designed to support receiving and discharging rates specified in the individual ship class characteristics at a minimum pressure of 40 psi. Filling and offloading systems consist of separate port and starboard mains with risers from the pump room. Each main has separate branches to each filling or offloading station.

Cargo receiving stations are similar to those on warships described in Paragraph 2-2.2.2. Offloading stations have a 90-degree elbow, quick-closing valve, throttling valve, and 45-degree elbow with an 8-inch flange drilled and dimensioned for attaching a 7-inch hose.

The cargo oil piping in the tanks consists of tailpipes and mains with a flexible capability for filling, offloading, transferring, ballasting, and deballasting. Wherever practical, valves in cargo oil fill and suction tailpipes are in the pump room. The DFM cargo oil pumps are arranged to take suction only on the DFM cargo tanks through valved suction mains and to discharge to the risers to the replenishment stations. Pump room DFM cargo piping is arranged to:

- Transfer fuel from the cargo tanks to the ships transfer system.
- Permit the cargo tanks to take suction from and discharge to any cargo tank carrying DFM.
- Permit the DFM cargo pumps to deballast any cargo oil tank.
- Receive fuel from either side while discharging to the opposite side.
- During simultaneous replenishment of ships on both sides, completely segregate the product being delivered to either side.

Cargo oil tanks are fitted with stripping systems with tailpipes at the low point near the after end of each tank. Stripping pump suctions have a capped hose valve. This hose valve is for attaching hoses to cargo oil piping low points drains, but provides salvors with another point for entering fuel oil piping.

All replenishment ships and tankers have Butterworth openings for tank cleaning machines. Over-the-top transfers through these openings are discussed in Chapter 5.

2-3.2.2 <u>JP-5 Cargo Systems in Replenishment Ships</u>. Both within the ship and at the filling and replenishment stations, JP-5 cargo systems in replenishment ships are similar in configuration to DFM cargo systems. JP-5 cargo systems are completely separate systems with their own pump room. These systems vary slightly from DFM systems as their pump room piping is arranged to:

- Permit any JP-5 cargo pumps to take suction from and discharge to any cargo tank carrying JP-5.
- Permit the JP-5 cargo pumps to take suction from the sea and discharge to cargo or ballast tanks.
- Permit the JP-5 cargo pumps to deballast cargo tanks.
- Receive fuel from either side while discharging to the opposite side.
- During simultaneous replenishment of ships on both sides, completely segregate the product being delivered to either side.

JP-5 cargo tanks on replenishment ships have two electrical liquid level indicating systems that read out in the cargo fuel control center. One system shows the air-fuel interface; the other the fuel-water interface.

In addition to the capped hose valves on the suction side of the stripping pumps, JP-5 cargo systems have the following hose connections:

- A 2½-inch connection on one port and one starboard fueling at sea station.
- A 1½-inch low point drain in each of the piping loops or mains in the pump room.
- A 1½-inch low point drain in each cargo pump discharge downstream of its check valve.
- A 1½-inch low point drain between each cargo tank bulkhead cutout valve and the associated fill main cutout valve.

2-4 <u>OTHER OIL SYSTEMS</u>.

In addition to fuel and cargo oils, other oils for consumption by the ship may be carried. The most common are lubricating oil and jet fuel for aircraft operating from the ship.

Steam ships normally carry sizeable amounts of lubricating oil in sumps under their reduction gears or in gravity tanks high in the engine room. There is usually a storage tank for lubricating oil, so located and plumbed, that oil may be provided directly from it to the lubricating oil sumps or gravity tank. There is bulk storage of fairly large quantities of lubricating oil on all diesel-powered ships, usually in tanks in or near the engine room. Normally, lubricating oil is handled totally within the engine room. Tanks and lubricating oil systems have no special features that either expedite or inhibit handling oils from these systems. Salvors must be aware that lubricating oil must be removed from main engine sumps as well as separate tanks in diesel ships.

JP-5, a kerosene type fuel with a relatively high flashpoint, is the only jet fuel used aboard U.S. Navy ships. Commercial vessels that operate aircraft and ships of other nations may carry more volatile jet fuels. JP-5 tanks are not protected by inerted cofferdams or special piping. Jet fuel systems on foreign ships may have one or both of these features. As the aviation capabilities of warships vary greatly, so do their aviation fuel systems. If it is necessary to remove jet fuel from an aviation-capable casualty, the details of the particular ship's aviation fuel system must be determined. JP-5 may be handled with the same methods and precautions as DFM and other light fuels. Expert advice should be sought for handling jet fuels other than JP-5. If expert advice is not available, fuels may be handled by the water displacement method described in Paragraph 3-3.2 to minimize fume formation.

Amphibious ships and some other ships carry motor gasoline. Gasoline is carried in inerted or water displacement tank systems and is pumped through double-wall pipes that have inert gas between the walls. Gasoline pipes are protected by trunks. Gasoline is very volatile and very dangerous; it is always handled by water displacement.

Ships with large quantities of hydraulic machinery may carry separate bulk storage for hydraulic fluid. Hydraulic fluid storage may be either in the machinery spaces or near the equipment served.

Ships operating in extreme high or low latitudes may carry Diesel Fuel, Arctic (DFA) (FEDSPEC BVF800)—ordinary diesel fuel lightened with kerosene to improve its cold weather performance. Arctic diesel fuel is stored and handled in the same way as DFM. Ships that operate in polar regions may also carry JP-8. The flash point for JP-8 and DFA is about 100 °F, whereas JP-5 and DFM are around 140 °F.

2-5 ROUTINE FUEL AND CARGO TRANSFERS.

Routine fuel and oil cargo transfers include:

- Fueling—both underway and in port.
- Internal transfers.
- Transfers to other ships.
- Defueling.
- Cargo loading.
- Cargo discharges.

All the transfers are normal operations for the ships and are conducted more or less routinely with equipment and systems built into the ship. The equipment and systems are operated within their design parameters and perform the functions for which they are intended.

In naval vessels, the routine fuel and oil cargo procedures are detailed in the EOSS. Such detailed procedures are rarely available on commercial vessels, but written operational procedures for operation of all equipment systems should be available. In foreign ships, the crew can be invaluable not only in interpreting the system, but also in translating plans and operating procedures. The Coast Guard requires U.S. flag tankers to have an *Oil Transfer Procedure Manual* that describes the specific ship's systems, piping, pumps, etc. This manual also describes the location of safety and firefighting equipment. Copies are available from the master or chief mate, and in the cargo control room. Shipboard Oil Pollution Emergency Plans (SOPEPs) are required on all oceangoing oil tankers of 150 gross tons or more and all other vessels of 400 gross tons and above that operate in the navigable waters of the United States. The SOPEP is different from the Oil Transfer Procedure Manual in that it provides the ship’s crew with detailed procedures to follow when a pollution incident has occurred or is likely to occur.

In emergency transfers, it is often necessary to deviate from prescribed procedures. Every attempt should be made to adhere to them as closely as the situation permits and to integrate the installed equipment and systems into the operation as much as possible.

CHAPTER 3
OPERATIONS PLANNING AND PREPARATION

3-1 INTRODUCTION.

When ships carrying large quantities of oil (such as tankers, oilers, large combatants, or auxiliaries) become casualties, reduction of the pollution risk—and, often, salvage—requires the removal of their cargo. The emergency transfer of petroleum cargoes from tankers and oilers is the most complex emergency transfer task because of the quantities of petroleum handled. The dangers of day-to-day operation of tankers and other ships that carry large quantities of petroleum products is recognized in the design and construction of the ships and the training of their crews. When these vessels become casualties, their built-in safety systems may be damaged or destroyed and the degree of risk thereby increased. This chapter covers planning and preparation for the emergency transfer of large quantities of fuel or cargo oils, including mooring and fendering arrangements for lighters. Chapter 4 addresses specific techniques for the removal and transfer of fuel bunkers and miscellaneous oils, while Chapter 5 addresses the specifics of salvage cargo lightering.

Although ship-to-ship cargo transfers are standard operations in both naval and commercial vessels, emergency transfers are neither standard nor routine. As variations of standard procedures carried out under less than optimum conditions, emergency transfers are complex and are inherently dangerous. Emergency POL transfers should be viewed as an integral part of a salvage operation and planned with the same thoroughness and meticulousness as other salvage evolutions. It is mandatory that safety receives special attention and that, in addition to the specialized tanker safety rules, all salvage safety rules are followed exactly.

Emergency POL transfer has three purposes:

- To prevent pollution,
- To lighten the vessel for salvage, and
- To save the cargo.

While the relative priorities of the three purposes may vary from operation to operation, all are important and must be considered at every point during planning and in the operation itself.

Usually, cargo is removed by bringing a receiving or lightering vessel to the casualty site and pumping the casualty's cargo to it. When the casualty is at a terminal or can be brought to a terminal, the cargo may be pumped ashore. If the casualty's hull and her systems are intact and her pumps are operable, the transfer may be made with the casualty's installed systems. If the installed systems are inoperable, specially designed portable pumps put into the tank through the Butterworth openings or tank access hatches will pump the cargo over-the-top to the receiving vessel.

Responsibilities and tasks must be clearly defined before any emergency POL transfer. In any casualty, overall responsibility for the casualty vessel, crew, and cargo remains with the casualty's commanding officer or master. The On-Scene Commander (OSC) or the salvage officer develops the transfer plan and has operational responsibility for the transfer.

3-2 OPERATIONS PLANNING.

The transfer operation must be planned quickly and thoroughly from the best available information. The basic plan is changed as the situation develops or additional information becomes available. The emergency transfer plan is normally a part of the overall salvage plan. The plan should:

- State the goal of the operation.
- Describe the situation.
- State command and control procedures.
- State logistics requirements.
- Describe the transfer operation.
- Delineate safety, pollution control, and firefighting measures.

The safe transfer of petroleum requires expert knowledge. Experts in the shipping and safety requirements of the particular petroleum product should participate in all phases of transfer planning.

3-2.1 Transfer Goal. A concise and realistic statement of the transfer goal is the first step of plan development. The transfer goal determines procedures that, in turn, determine logistics, equipment, and personnel requirements. The transfer goal is reassessed as the operation progresses to be sure the desired progress is being made and that the goal remains achievable. Transfer goals may differ widely in their ultimate purpose. That purpose may be to prevent pollution, to gas-free a wreck for cutting, or for some other purpose or combination of purposes.

3-2.2 The Situation. The plan describes the situation in detail. The operation should not proceed until the salvage officer is satisfied that the situation is understood as completely as possible. Every effort should be made to get accurate and complete information. The completeness and quality of information should be assessed, missing or suspect information noted, and as many holes as possible filled.

3-2.2.1 Survey. As in all salvage operations, a thorough, detailed survey is necessary to understanding the situation. Because of the nature of emergency transfer operations, the survey includes information not found in the salvage surveys described in other volumes of the *U.S. Navy Ship Salvage Manual*. Appendix D includes an initial survey information form for transfer of petroleum cargo.

3-2.2.2 Vessel Characteristics. Particulars and procedures for naval vessels are found on board the ship or obtained from the type commander. Military Sealift Command (MSC) Area Commanders have information on ships owned and chartered by MSC. The American Bureau of Shipping (ABS) Register and Lloyd's Register are primary sources for basic characteristics of commercial ships. The American Bureau of Shipping Register lists only ships classed or assigned a load line by the ABS. Specific information is available from the vessel's owner or operator and on board the vessel. Section 3-3 of the *U.S. Navy Ship Salvage Manual, Volume 1 (Strandings, Harbor Clearance, and Afloat Salvage),* S0300-A6-MAN-010, describes sources of information about ships and the type of data that can be expected from each source. The following specific information about each ship should be obtained:

- Length overall (LOA).
- Distance from the center of the manifold to the stern.
- Permanent or temporary obstructions on the sides.
- Numbers and locations of chocks and bitts.
- Type of inert gas system.
- Number and type of cargo pumps.

3-2.2.3 POL Characteristics. Because POL characteristics vary widely, those specific to the product to be transferred must be determined. The quantity and characteristics of the POL to be transferred determine the types of receiving vessels and special handling requirements. Cargo manifests or loading records contain cargo information.

3-2.2.4 The Transfer Site. The site for transferring cargo from a stranded or sunken ship cannot be chosen. If the ship is afloat and can be moved, conducting the transfer operation at a protected site increases the probability of success and reduces risks to ships and personnel. The best transfer locations are sheltered from adverse weather and sea conditions. The site can be a port, a coastal or island lee, or an open water location with favorable conditions.

Site conditions that influence the transfer include:

- Currents.
- Water depth.
- The need for mooring systems, fenders, and support craft.
- The type of bottom.
- Accessibility to grounded vessels.
- Tidal action.
- Weather and sea conditions.

Few local governments will bear the real and political risks of bringing a leaking vessel into port in peacetime. Moving a damaged ship within a port may not be permitted because of the risk of spreading pollution. Environmental considerations may cause authorities to dictate where a casualty should go, or to direct it to remain clear of their waters.

Salvors should clearly explain the situation to local authorities and present a thorough operations plan that emphasizes safety and pollution prevention. Often, satisfactory compromises on location and other matters can be reached.

3-2.2.5 Weather. Accurate and timely weather forecasts and observations are an absolute necessity for safe and efficient transfer operations. When there is inclement weather at the casualty site, the operation should be moved or delayed until the weather improves. Thirty-knot winds, swells of approximately 10 feet, and rolls of 4 degrees have proven to be about the most adverse conditions in which routine ship-to-ship transfers can take place. Transfers should not begin if more severe weather is forecast.

Because of the many variables, universal weather criteria for terminating emergency transfer operations cannot be established. The criteria must be tailored to the location, the size of the ships involved, their response to seas, the condition of the casualty, the product being transferred, and the type of weather expected. It is desirable to be ultraconservative in terminating transfers for weather. The risks of continuing a transfer operation in bad weather are seldom, if ever, warranted.

3.2.3 Command and Control. A system of command and control for the operation must be specified in the transfer plan and adhered to strictly throughout the operation. If civilian agencies are involved, a coordinated or unified command system may be required to manage various agency resources and concerns. In U.S. waters, command and control may incorporate aspects of the National Incident Management System (NIMS).

3-2.3.1 Chain of Command. The chain of command must be clear to ensure that critical information and decisions are received without delay by those who must take action. Full definition of responsibility and authority avoids redundancy, confusion, and time loss.

3-2.3.2 Organization. All key positions should be shown on a chart that defines job responsibilities and specifies the person charged with each responsibility.

3-2.3.3 Command Center. A command center for directing and controlling salvage and transfer actions and for keeping logs and records should be established. This command center should have direct access to support commands, port authorities, pilot services, and civil authorities. A listing of local authorities and other interested parties should be developed. These interests should be kept advised of proposed operations and progress. Press briefing areas should be kept clear of operational areas and the command post.

3-2.3.4 Communications. Rapid, effective communications among the casualty, receiving vessels, support craft, and shore support is essential. Communications must be in a common language. When participants speak different languages, the English-based Standard Marine Navigational Vocabulary published by the International Maritime Organization (IMO) is appropriate. The IMO publication that contains the standard vocabulary (SeaSpeak) should be on the bridge of any tanker of an IMO-member nation.

Watch standers must have access to an open broadcast or hard wire channel for alerting all stations in an emergency.

Communications planning should include:

- Types of equipment and frequencies for intership radio communications.
- Types of equipment and channels for intraship radio communications.
- Restrictions on electromagnetic radiation.
- Emergency radio communications.
- Procedures for loss of communications.

3-2.4 Logistics. Carefully structured logistics are mandatory to achieve a fully planned and well-executed transfer operation. If logistical support lines and routes are long or complex, there may be delays in supplying the operation. A thorough evaluation of logistics should be prepared to determine if the operation can proceed without all equipment on site at the outset.

While every situation will be different, some logistics factors must be considered in all plans:

- Source, location, and transportation of required equipment and specialized personnel.
- Material-handling equipment requirements for each intermodal transfer.
- Customs and cabotage requirements.
- Boat, tug, and small craft support.
- Safe Berth provisions for chartered lightering vessels.
- Fuel for boats, craft, and portable equipment.
- Maintenance and support for vessels and equipment.
- Documentation and reference material.
- Support personnel accommodation.
- Disposal plan for recovered POL.
- Demobilization.

3-2.5 Operations. The operations section of the plan describes personnel and equipment requirements and all activity during the transfer operation. It must be tailored to each specific operation considering the factors that affect that operation. The period of plan development is an excellent opportunity to ask "what if...?" about every aspect of the operation and to provide contingency plans for all credible events.

3-2.5.1 Personnel. The officer in charge of lightering should be qualified and experienced in POL transfer and salvage operations. The trained team required to operate portable systems may include supervisors, tanker safety specialists, engineers, divers, marine chemists, pump operators, and an inert gas generating crew. If the crew of the casualty is not available, or if logistical conditions are difficult, riggers, deck hands, equipment operators, and machinists may also be needed as part of the transfer team. The need for these skills should be anticipated and personnel brought to the scene before they are required. Local authorities may enforce licensing requirements, particularly those involving fuel transfer operations.

3-2.5.2 Equipment Requirements and Availability. A bill of materials for equipment is developed from an analysis of the operation. Sources for all materials are defined and availability established; then arrangements are made for acquiring and transporting the materials to the site.

In emergency transfer operations, equipment redundancy of 100 percent or more is prudent for operational continuity. Circumstances such as a remote geographical location, limited weather windows, or questionable condition or reliability of shipboard equipment may dictate bringing portable systems to the site as a backup.

Requirements for support vessels should be detailed and the time needed for the vessels to transit to and arrive on the site projected. Arrangements should be made to fuel and maintain support vessels and to house and support boat crews when there are no accommodations on board.

The *Emergency Ship Salvage Material (ESSM) Catalog,* NAVSEA 0994-LP-017-3010, describes transfer equipment available in the ESSM inventory. Appendix C gives some characteristics of this equipment and a hyperlink to the ESSM catalog. Arrangements for ESSM equipment are made through the Supervisor of Salvage.

3-2.5.3 Positioning and Mooring. The positions and mooring of the casualty and receiving vessels should be defined completely. To be defined are:

- The receiving vessel's approach to the casualty.
- Minimum separation.
- Type, number, and arrangement of mooring lines.
- Type, number, and arrangement of fenders.
- Ground tackle and mooring plans.
- POL transfer lines.
- Arrangements for prevention of flow of stray electric currents and the accumulation of electrostatic charges.
- Communications.
- Emergency shutdown and disconnect procedures.
- Firefighting and safety arrangements.
- The vessel that is to supply specific resources.

The ship supplying the hoses and mooring lines should determine:

- Layout of the other ship's mooring fittings and equipment, and arrangements for handling lines.
- The size, class, and condition of manifold flanges.
- The maximum height of manifolds above the waterline during the operation.
- The relative freeboards.
- The condition of lifting gear and its ability to handle cargo hoses and other loads.

3-2.5.4 Transfer Operations. The following specific items must be addressed in the operations section of the plan:

- Transfer hoses and how they will be rigged.
- Pumping systems for the transfer.
- Transfer rates that are expected.
- Predicting and tracking hull stresses on both casualty and lightering vessel with installed load computers or by other means.
- Tank sequencing.
- Ballasting and ballast discharge.
- Tank stripping.
- Tank gauging.
- Gas buildup detection.
- Manning.
- Communications.
- Normal and emergency shutdown.
- Getting underway normally and in emergencies.

3-2.5.5 Termination. The termination of an emergency transfer operation deserves the same careful planning as other phases. Haste in terminating the operation fueled by a desire to move on to the next phase should be avoided. The termination and getting underway should proceed with deliberation. Points to be addressed in the termination plan include:

- Decision criteria for termination.
- Hose draining, disconnecting, and handling.
- Blanking of manifolds and hoses.
- Preparations for getting underway.
- Procedures for getting underway.

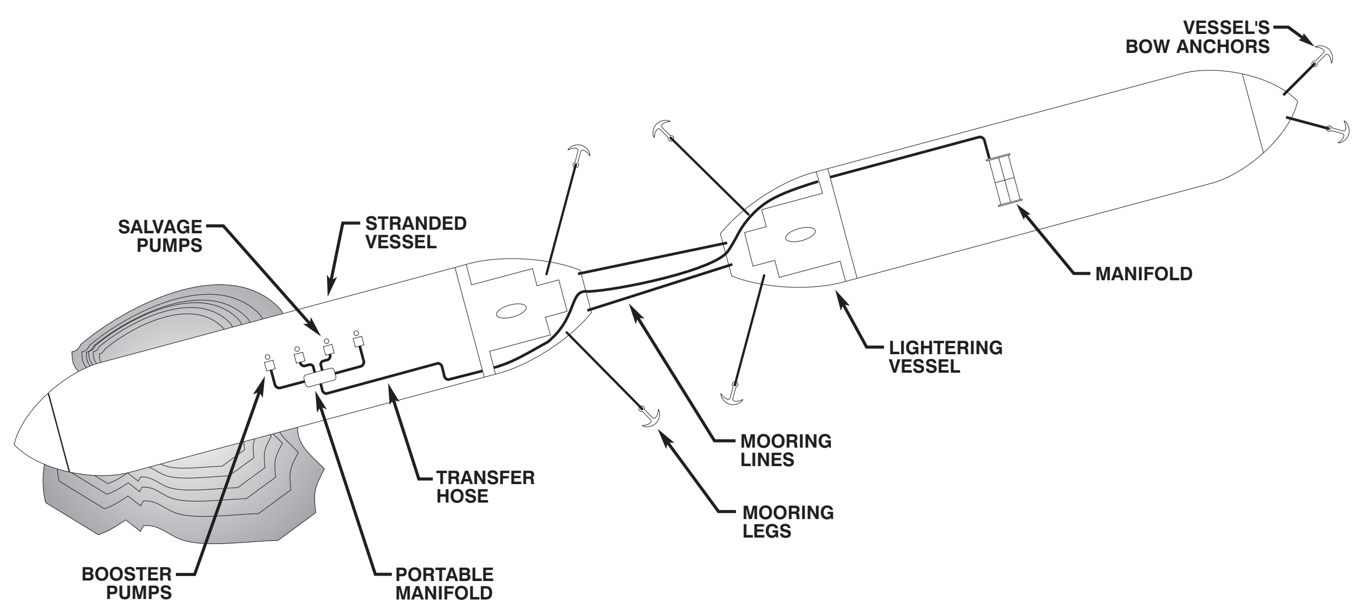


Figure 3-1. Stern-to-Stern Mooring.

3-2.6 Safety, Pollution Control, and Firefighting. In addition to the general safety, pollution control and firefighting measures applicable to all salvage operations, safety, pollution control, and firefighting systems must be planned and tailored to the particular operation. An accident, oil spill, or fire can be catastrophic; no short cuts should be taken in planning safety, pollution control, and firefighting. Complete rather than minimum protection should be the standard. Safety, pollution control, and firefighting measures must be in place before oil is transferred.

3-2.7 Acceptance of the Receiving Vessel. The salvage officer and safety officer should inspect the receiving vessel to ensure that:

- Her certifications are up to date,
- Her material condition and safety equipment are satisfactory, and
- She can complete the transfer.

Appendix D contains a sample check list for inspection of a receiving vessel. Unsatisfactory vessels should be rejected. If the receiving vessel is satisfactory, the commanding officer and cargo officer or master and mate of the receiving vessel should accompany the salvage officer and safety officer on a joint inspection of the casualty. These inspections are mandatory. They should never be omitted.

3-2.8 Plan Review. The completed operations plan is thoroughly reviewed, then promulgated at a technical conference. At the technical conference, the entire plan is discussed, and changes are considered and included when appropriate. Conference attendees should include key operational personnel, the commanding officers of the casualty and receiving ships, and representatives of the type commander, or owner, cargo owner, and involved agencies. The organization of the operation is reiterated to clarify responsibilities. Key operations schedules, procedures, and all emergency signals are reviewed.

3-3 MOORING.

If ships are mobile and equipped for underway replenishment, cargo can be transferred by the procedures detailed in *Replenishment at Sea,* NWP 14, and the ships need not moor. Otherwise, they must moor for the transfer.

3-3.1 Mooring Operations. With tankers not equipped for underway replenishment, experience has shown that the most successful mooring operations are conducted with both ships underway. Underway mooring or transfer may be neither possible nor desirable when one ship is a casualty.

Mooring operations with one ship at anchor should be undertaken only in good weather. When wind and tide are from different directions or the wind is variable in velocity and direction, the anchored ship can yaw, making the mooring process difficult. Tugs may hold the anchored ship on a steady heading or assist the maneuvering ship. The maneuvering ship typically moors port side to; however, with tugs, she may moor either side to.

With immobilized casualties, existing conditions of heading and weather must be accepted. Tugs are almost always required to moor a receiving vessel alongside an immobile vessel, especially in restricted waters. Conditions may make alongside mooring impractical. In these cases, the vessels may moor stern-to-stern or the receiving vessel may stand off and receive cargo through a floating hose.

Night mooring operations involving tankers are invitations to disaster and should be avoided. If night mooring cannot be avoided, the operation must be planned meticulously and carried out with extreme care. If *anything* does not go according to plan, the operation should be aborted. At night, the berthing side should be well lighted, but the lights should not blind those on the bridge of the approaching vessel. Spot lights should illuminate fenders.

Lines may be passed by hand or with line-throwing guns. Line to tankers should not be passed with line-throwing rockets because of the danger of the hot rocket igniting fumes from the tanker. When lines are passed by line-throwing guns, the forward deck of the ship to which lines are being passed should be cleared of antennas or other obstructions, and an audible warning should be given before firing. A mooring crew and equipment may be put aboard an unmanned casualty before the receiving vessel's approach. If the casualty is without power and portable machinery cannot be put aboard, the receiving ship or a support vessel must provide winch and handling equipment assistance.

Whatever the method chosen, mooring arrangements are determined during planning. The receiving vessel is outfitted during mobilization. Mooring lines are made ready with stoppers, messengers, and heaving lines. The decks of both vessels on the side proposed for berthing should be cleared of obstructions. There must be radio contact between the bridges and the mooring teams on both ships.

3-3.1.1 Underway Mooring. When both ships are underway, one ship—usually the larger—maintains bare steerageway on the heading requested by the maneuvering ship. Normally, the wind and sea are put dead ahead. The second ship approaches at a shallow angle and maneuvers alongside. The maneuver that has proven most effective is for the maneuvering ship to parallel the course of the other ship 50 to 100 yards off, match manifold positions, and close gradually. When the ships have closed, lines are passed and secured in accordance with the mooring plan.

The effects of hydrodynamic interaction between the ships should be anticipated during maneuvering in close quarters. The forward motion of the ships driving the sea between them may push the bows apart. To help counter this effect, the head and forward breast lines should be secured as soon as possible.

Once the vessels are made fast, the vessel designated by the salvage officer maintains headway, towing the other vessel alongside. The other vessel maintains its propulsion and maneuvering plant in readiness to supplement rudder and propulsion power. Tugs should remain fast to a lightering barge. Relative motion and turbulence between the two ships should be kept to a minimum to keep mooring loads low.

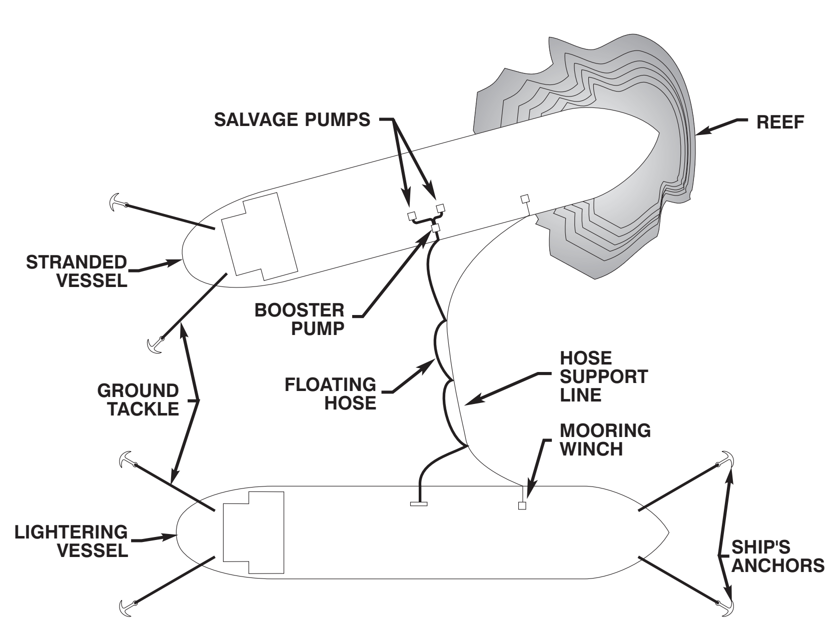


Figure 3-2. Standoff Mooring.

The transfer may be made underway, at anchor, or drifting.

If the water is too deep for anchoring, there is adequate sea room, and traffic conditions are favorable, the transfer may take place underway with one ship towing. When sea conditions and the available sea room permit, the vessels should choose a heading to give a relative wind that carries hydrocarbon vapors clear of the ships, and clear of ventilation intakes in particular.

For transfers at anchor, the ships proceed to the designated anchorage after completing the mooring. The anchoring ship should be positioned with its anchor on the side opposite the moored ship. The anchoring maneuver should be carried out without strong astern movements.

Drifting transfers may be carried out when there is sufficient sea room, weather conditions are good, and the drift area is clear of traffic.

3-3.1.2 Mooring at Anchor. The mooring-at-anchor operation is similar to the mooring underway operation. One ship anchors in a designated position with its anchor on the side opposite to that on which the maneuvering ship will moor. When the anchored ship is lying steady with respect to the wind and sea, the maneuvering ship comes alongside. The heading of the anchored ship is watched carefully and the maneuvering ship advised of any yawing. If yawing is excessive, tugs should assist mooring.

3-3.1.3 Mooring When the Casualty is Immobile. When the casualty is aground or otherwise immobile, the receiving vessel may moor alongside if there is sufficient water depth in the approaches and alongside. There must be enough water depth alongside for the receiving ship to remain safely afloat with her full expected load at all stages of the tide. Because the position of the immobile ship relative to the wind and sea cannot be controlled, tugs assist the maneuvering ship.

Alternatively, the receiving vessel may moor stern to the casualty's stern or bow. This type of mooring is made as close to the casualty as is safely possible to minimize the length of the discharge hose. Before the receiving ship approaches, the casualty is secured against movement by ground tackle, laid as is appropriate for the situation and the weather. The receiving ship should make a practice approach, setting markers for turning and anchoring. To make her moor, the receiving ship anchors with her bower anchors to position the ship away from the casualty; tugs and support vessels then assist in maneuvering, running ground tackle, and passing transfer hoses. It is preferable to lead transfer hoses to the sterns of the two ships rather than leading floating hose over the side at the manifolds. Stern-to-stern mooring is possible only in favorable weather and seas. Figure 3-1 illustrates a stern-to-stern moor to a stranded tanker. During a transfer operation, a stranded tanker should be ballasted heavily to prevent her coming afloat prematurely.

If the casualty cannot be approached closely or an alongside or stern-to-stern mooring cannot be made safely, the receiving vessel may anchor clear and float transfer hoses between the ships. The hose, subject to sea and current and the weight of the POL, may be difficult to tend. Figure 3-2 illustrates a stand-off mooring arrangement.

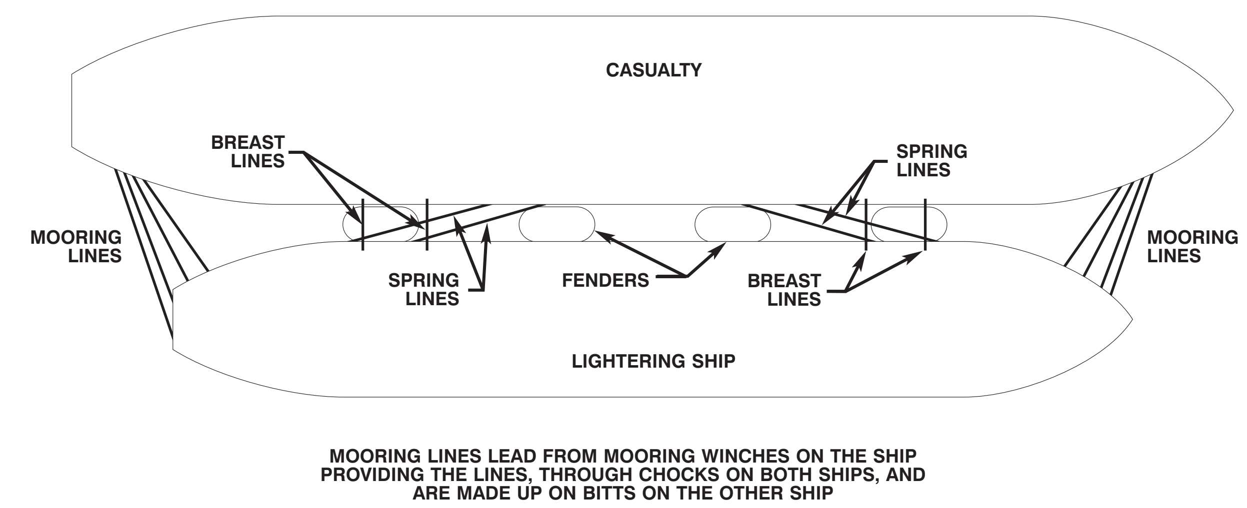


Figure 3-3. Typical Mooring Line Arrangement for Alongside Transfer.

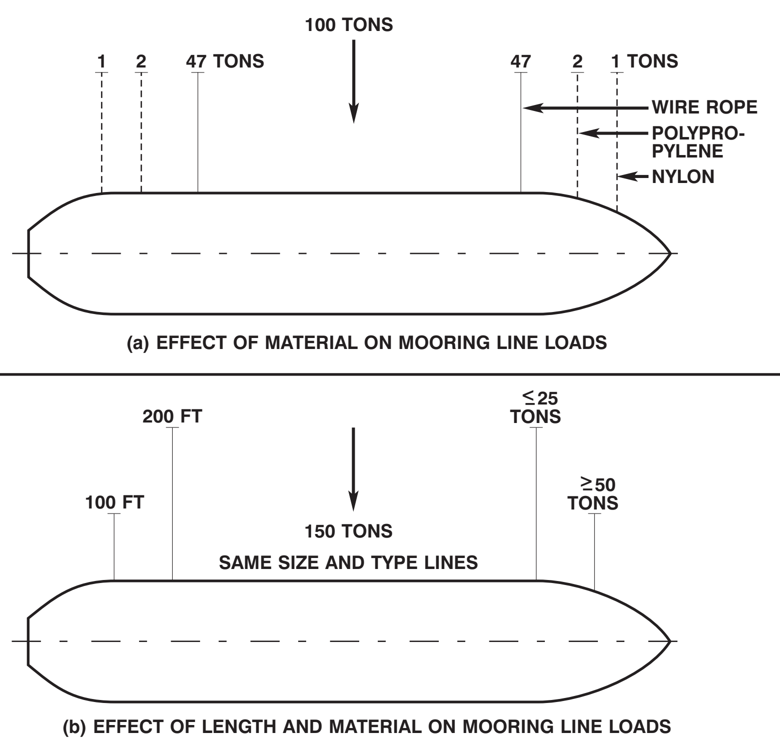


Figure 3-4. Effect of Length on Mooring Line Loads.

3-3.2 Tug Assistance. Tug assistance is required or advisable in most types of alongside mooring. The type of tug is important. Salvage ships and tugs are poor ship assistance tugs because of their size, arrangement, lack of adequate fendering (in most cases), and relatively slow response to changes in propeller and rudder settings. If enough ship assistance tugs are not available to ensure a safe alongside or stern-to-stern mooring operation, a stand-off moor should be chosen.

3-3.3 Mooring Lines. Mooring loads for vessels of different sizes moored together in a seaway are difficult and inexact to calculate. Mooring with lines and an arrangement suited to the larger ship at a pier normally will be sufficient. Figure 3-3 illustrates a mooring arrangement that has proven satisfactory in alongside transfers. For all mooring operations, good quality mooring lines and efficient winches and deck machinery are important. Mooring lines should all be of the same materials and construction. Wire rope is preferred for mooring large ships. Moorings should not be composed of all highly elastic lines, as currents and sea conditions can induce excessive movement.

The load carried by a line is directly proportional to its stiffness. Stiff lines carry more of the load than do elastic lines. Wire and fiber ropes should, therefore, not be mixed in moorings. The stiffer material—the wire rope—will carry almost the entire load while the fiber rope carries practically none. Elasticity varies with length as well as material. Long lines are more elastic than short ones. Figure 3-4 illustrates the effect of material and length on the load carried by mooring lines. Mooring patterns should not have lines of different elasticities running in the same direction. Fiber lines may be the first line over and can assist in positioning the ships at either end. These lines should not be considered as adding to the strength of the moor.

Tanker operators no longer slush mooring wires because slushed wires leave a slick if they drag in the water. The slick earns fines for the operators. Lacking lubrication, the wires corrode, have a relatively short working life, and are subject to failure in service. It has become a routine practice to parallel wire rope mooring lines with synthetic fiber rope mooring lines. Further, because of the high cost of wire rope, most tankers carry only a few wire rope mooring lines. Therefore, even though mixtures of wire rope and synthetic fiber wire rope mooring lines should not be used, they are common. In both the cases of parallel wire rope and synthetic fiber rope mooring lines and mixtures, the wire rope, the stiffer material, will carry nearly all the mooring load. The synthetic fiber lines act primarily as backup in the event of wire rope failure. Mixed moorings and corroded mooring wires are not desirable, but they are realities that must be expected in dealing with tankers.

Mooring lines between ships in the open sea are subject to dynamic loading from swells and waves. Fiber rope tails on wire rope mooring lines provide elasticity that assists in absorbing dynamic loads. The tails also provide for ease of handling, emergency break away, and some degree of electrical discontinuity. The tails should be about 35 feet long and, when made up in the moor, extend about one-third of the distance between the ships. Fiber rope tails should be made up to the wire rope mooring lines with special shackles of the type illustrated in Figure 3-5. The breaking strength of the fiber rope tail normally should be at least 25 percent greater than that of the wire rope. If the tails are made up specifically for the operation and will be discarded after the operation, they may have the same breaking strength as the wire rope.

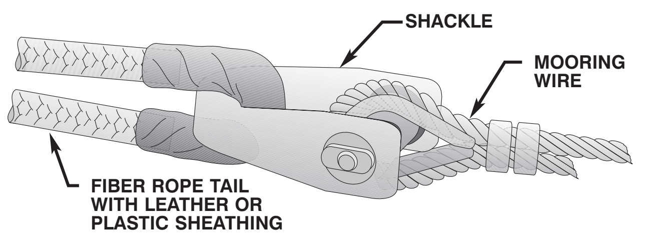


Figure 3-5. Stainless Steel Shackles for Lines with Tails.

The relative freeboard of the two ships is important to mooring efficiency. When the freeboard difference exceeds about 30 feet, the vertical component in mooring lines can exceed the horizontal mooring restraint. If excessive freeboard differences are unavoidable, the mooring should be reinforced by additional lines.

Mooring lines lead from mooring winches on the ship providing the lines, through closed chocks on both ships, and are made up on bitts on the other ship. The bitts should be as nearly in line with the chocks as possible. Lines should not be figure-eighted directly onto bitts. On large bitts, two round turns should be taken on the outboard post before figure-eighting. On small bitts, two round turns are taken around both posts. This arrangement is both safer and easier to work that simple figure-eighting. Figure 3-6 shows the correct makeup of lines on bitts.

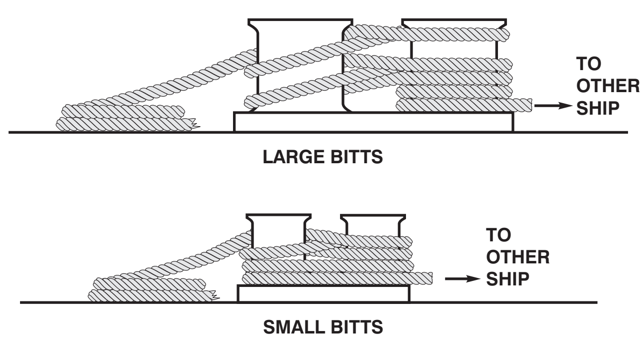


Figure 3-6. Mooring Lines Correctly Made Up on Bitts.

Mooring lines that are bent sharply are subjected to high bending stresses, greatly reducing their load-carrying capacity; lines are led through chocks to avoid these bending stresses. Mooring lines should lead through closed chocks whenever possible so the line remains in the chock as the relative freeboards change during transfer. Preventers should be rigged on open chocks to keep the mooring line from jumping out of the chock. All mooring lines passing through chocks should have chaffing gear. Chaffing gear is particularly important on wire rope mooring lines because the wire rope may cause damage to the surface of the chock. The damage to the chock may, in turn, damage mooring lines or spark in contact with wire rope.

Automatic tensioning mooring winches should not be in the automatic mode during transfer operations because winches may render and work against one another, causing the ships to move uncontrollably. Brakes should be set and the winches taken out of gear as soon as the ship is safely moored.

3-3.4 Emergency Tow Wires. Emergency tow wires must be rigged forward and aft on both ships. The wires should be in a position that the tugs can approach easily and should reach the water's edge. The slack is retained on deck, figure-eighted or faked down free for running, and restrained by fiber rope stops. Emergency tow wires should have a thimbled eye in the bitter end for pickup and attachment to the tug's tow line. The wires may be married to a floating line and buoy for pickup.

3-3.5 Lights. While not required by the *Rules of the Road*, it is good practice to display the red loading light on each vessel throughout the transfer in addition to the normal navigation lights.

3-3.6 Getting Underway. When the operation is complete, one or both of the vessels gets underway. There is often a temptation to try to refloat a lightened casualty with the receiving vessel alongside to hurry the operation. This procedure is very dangerous and should not be done except in calm waters when the receiving vessel is quite small. The receiving vessel no longer sees the casualty as a well-anchored pier and ranges up and down her side as she moves off her strand. With both vessels moving, the risk of an accident is great. A vessel moored in a stand-off position should be well clear of the expected track of the refloating vessel and of the probable paths of assisting tugs and support vessels.

Tugs may assist in getting underway, and may be especially valuable if the receiving vessel is alongside a stranded ship.

The receiving ship will be considerably deeper in the water when she gets underway than when she moored. Interaction with the bottom, as well as with the other ship, should be anticipated in shallow or shoal waters.

While getting underway there should be:

- Adequate crews on station,
- Radio communications among the bridges and mooring crews,
- Mooring winches ready for immediate service, and
- Axes, messengers, and stoppers at each mooring station.

When ships are anchored or underway, experience has shown that they may get underway satisfactorily by:

Letting go at one end,

- Allowing a shallow (5º) angle to develop,
- Letting go at the other end, and
- Allowing the ships to drift clear before either gets underway.

3-4 FENDERING.

Fenders of appropriate type and adequate size, number, and arrangement are required to absorb impact forces and prevent metal –to-metal contact between vessels moored alongside one another.

Fenders are placed on board the ship that maneuvers to make the mooring—usually the receiving vessel. If fenders are rigged on the casualty, the maneuvering vessel may contact the casualty between the fenders and cause damage.

3-4.1 Types of Fenders by Function. Functionally, there are three types of fenders:

- **Primary fenders** along the parallel midbody absorb impact loads during mooring and prevent contact as the moored ships move with the sea.
- **Secondary fenders** forward and aft of the primary fenders absorb loads and prevent contact during berthing and unberthing.
- **Tertiary fenders** protect overhangs and other places where contact is likely. Tertiary fenders are particularly important should the casualty have or develop a list.

3-4.2 Types of Fenders by Construction. By construction, there are four types of fenders:

- Foam-filled fenders.
- High-pressure (HP) pneumatic fenders.
- Low-pressure (LP) pneumatic fenders.
- Improvised fenders.

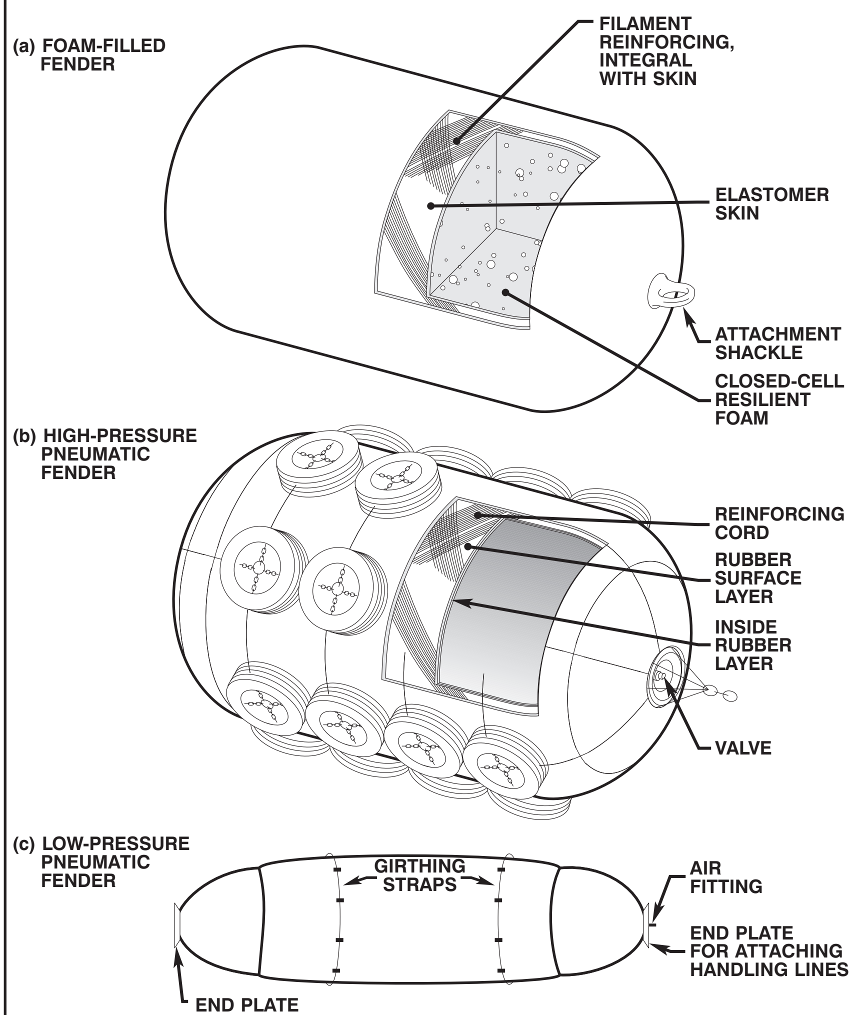


Figure 3-7. Fenders.

Each type has its advantages and disadvantages, but all can be used in any operation. The salvor will often have to develop a fendering system from less than optimum choices, especially when time and transportation are constraints.

3-4.2.1 Foam-filled Fenders. Foam-filled fenders are cylinders of a closed-cell polyethylene or polyurethane foam covered with neoprene or a polyurethane elastomer. End fittings are provided for handling and attachments. Foam-filled fenders are sometimes covered with a net of old tires connected by galvanized chain or wire rope. Commercially available foam-filled fenders range from 20 inches to 14 feet in diameter, from less than 5 feet to more than 28 feet in length, and from 75 to 16,000 pounds in weight. Figure 3-7(a) illustrates a typical foam-filled fender. The relative advantages and disadvantages of foam-filled fenders are listed in Table 4-1. The Supervisor of Salvage maintains 8' 5" diameter, 12' 0" long high-density foam-filled fenders in the ESSM System. These fenders are described in Appendix C.

3-4.2.2 High-pressure Pneumatic Fenders. The high-pressure pneumatic fender was the first large fender developed for separating vessels. It is essentially an air-filled cylinder of reinforced rubber. The fenders are inflated to between 7 and 11 psi through a filling valve located on one end. All fenders except the smallest ones are covered with a tire net for protection against chaffing. Commercially available fenders range from 20 inches to nearly 20 feet in diameter, from 39 inches to nearly 40 feet in length and from 112 to 29,000 pounds in weight. Figure 3-7(b) illustrates a typical high-pressure pneumatic fender. The relative advantages and disadvantages of high-pressure pneumatic fenders are listed in Table 4-1. There are no high-pressure pneumatic fenders in the ESSM System.

3-4.2.3 Low-pressure Pneumatic Fenders. Low-pressure pneumatic fenders are rubber cylinders filled with air to about 1 psi. Their construction is lighter than the high-pressure pneumatic fenders but they are fitted with protective tire nets only on special order. Low-pressure pneumatic fenders are rugged and have given excellent service in ship-to-ship transfers in sheltered locations and in moderate weather in the open sea. These fenders are built in diameters ranging from just over 3 feet to almost 15 feet. Lengths vary with application. The shortest practical length is about 2.5 times the diameter. Handling restricts the maximum length to about 100 feet. Weights range from 88 to 6,000 pounds, making these fenders relatively light and portable. Figure 3-7(c) illustrates a typical low-pressure pneumatic fender. The relative advantages and disadvantages of low-pressure fenders are listed in Table 4-1. Because of their transportability, ease of handling, and relatively small size, low-pressure pneumatic fenders are often the preferred choice for salvage and emergency transfer operations. Low-pressure pneumatic fenders are available in the ESSM System.

Table 3-1. Relative Advantages and Disadvantages of Different Fender Constructions.

ADVANTAGES	DISADVANTAGES
A. Foam-filled Fenders	
Greater energy absorption than high-pressure pneumatic fenders of the same size. No requirement to inflate. Will not collapse, sink, or lose energy absorption ability because of damage to the outer surface. Can be kept in service in damaged condition. Easily repaired.	Cannot be deflated for storage. Large volumes required for storage and transportation. Higher loading per unit area than low-pressure pneumatic fenders. Slower recovery rates under cyclic loading than pneumatic fenders.
B. High-pressure Pneumatic Fenders	
Can be deflated for storage and transportation. Can be partially deflated to decrease stand-off distance and area loading. Can be partially filled with water to reduce buoyancy and motions.	Requires a compressed air source for inflation. Bulkier than low-pressure pneumatic fenders. Must be taken out of service for repair if punctured. Inflation valves and blanking plates require maintenance.
C. Low-pressure Pneumatic Fenders	
Can be deflated, rolled up, and palletized for storage or transportation. Lighter than high-pressure pneumatic or foam-filled fenders for the same energy absorption. Lower reaction force per unit area than high-pressure pneumatic or foam-filled fenders. Can be partially deflated to reduce stand-off distances.	Are more susceptible to damage from sharp objects than foam-filled or high-pressure pneumatic fenders. Safety valves, charging connections, and blanking plates require maintenance. Must be removed from service for repairs.

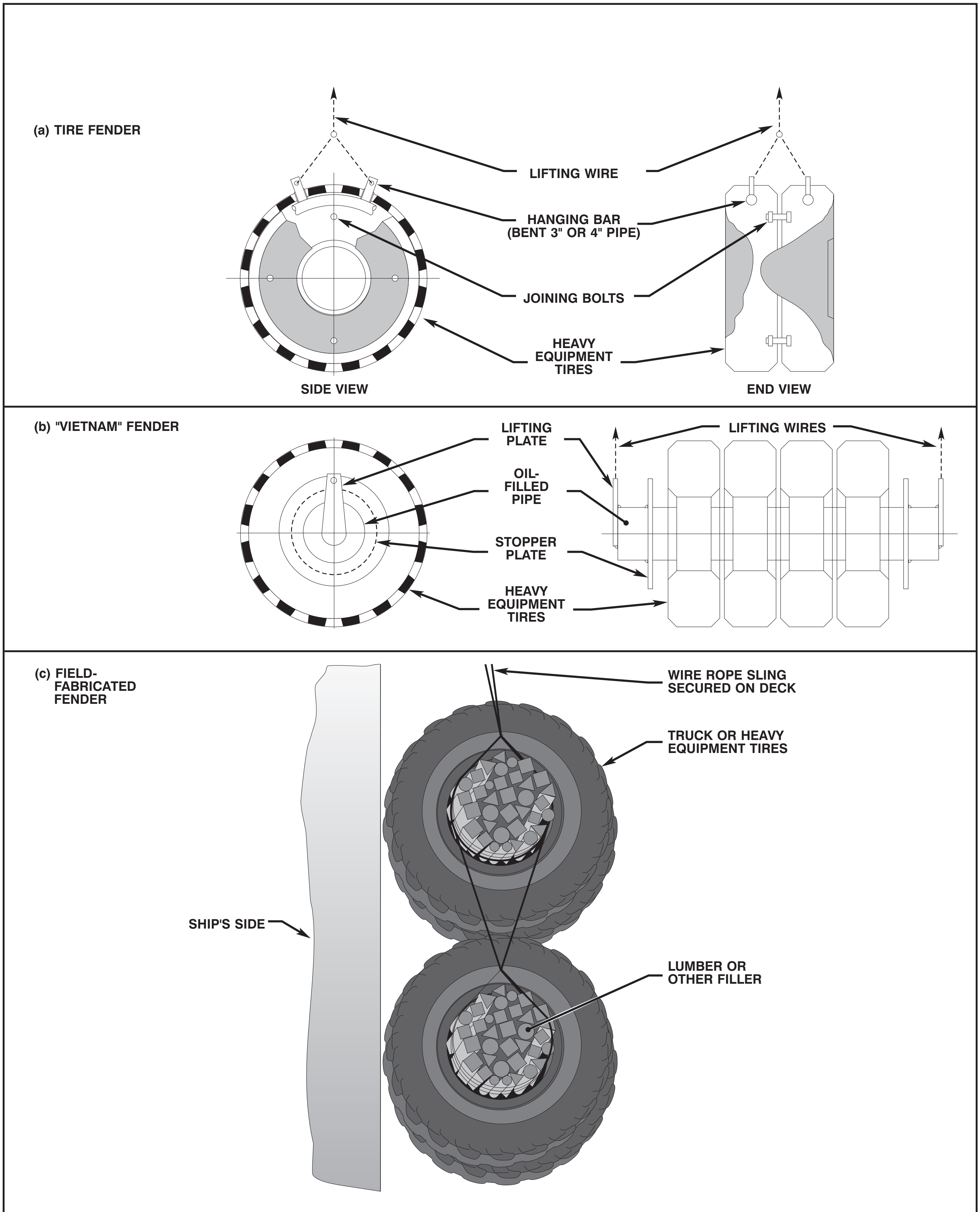


Figure 3-8. Improvised Fenders.

3-4.2.4 Improvised Fenders. Fenders may be improvised in the field from truck or heavy equipment tires. Except in very low energy environments with relatively small hulls, single tires hung with their walls against the ship's side are not effective fenders. Improvised fenders should be made of multiple tires hung with their tread against the hull. Figure 3-8 illustrates several types of improvised fenders. Tire fenders can be made more effective by stuffing them with old line or inserting an inner tube inflated to a low pressure so that it remains soft. Improvised fenders are never better than marginally adequate and should not be used when other types of fenders are available.

The 8.4-ton inflatable salvage pontoon can be rigged as a fender. It is roughly equivalent to a low-pressure pneumatic fender of the same size.

3-4.3 Fender Selection. The factors considered in selecting fenders for ship-to-ship cargo transfers are:

- Energy absorption,
- Freeboards of the vessels relative to fender diameter,
- Overhanging structure, and
- Local hull strengths.

The relative importance of the factors varies with the particular operation. The fendering system should be tailored to the operation at hand. Salvors often must make do with the fenders that are available or that can be brought to the scene. They must be aware of the compromises to be made in setting up a fendering system.

3-4.3.1 Energy Absorption. Absorption of the berthing energy of the two ships is a primary consideration in all fendering systems. One fender is assumed to absorb all the berthing energy. Fendering systems that absorb the berthing energy will be adequate to absorb the energy of the two ships moving in any seaway in which transfer is practical. The berthing energy is determined by the displacement of the two ships and the berthing velocity—the speed directly toward one another—of the ships.

In absorbing energy, fenders compress as they are squeezed against the ship. Manufacturers' data rate energy absorption against compression expressed as a percentage of the nominal fender diameter. Fifty percent compression is the greatest percentage that should be planned for in a salvage or emergency transfer operation. This percentage gives an adequate factor of safety based on the total energy absorption capacity of foam-filled and pneumatic fenders.

As the fender compresses, a larger area of the fender comes in contact with the side of the ship. Figure 3-9 shows a fender with 50 percent compression. The flat width in contact with the side of the ship is directly proportional to the amount of compression and can be calculated by:

$$\text{Flat width} = 0.0157 \times \%\ \text{Compression} \times \text{Fender Diameter}$$

EXAMPLE 3-1
CALCULATION OF FENDER FLAT WIDTH

a. What is the flat width of any fender compressed to 50% expressed as a percentage of the fender diameter?

The flat width as a percentage of fender diameter is:

$$\text{Flat width (\%)} = 0.0157 \times \%\ \text{Compression}$$

$$\text{Flat width (\%)} = 0.0157 \times 50$$

$$\text{Flat width (\%)} = 78.5\%$$

When any fender is compressed 50%, the flat width in contact with the hull is 78.5% of the fender diameter.

b. What is the flat width of a 6-foot diameter fender that is compressed 50%?

$$\text{Flat width} = 0.0157 \times \%\ \text{Compression} \times \text{Fender Diameter}$$

$$\text{Flat width} = 0.0157 \times 50 \times 6$$

$$\text{Flat width} = 4.71 \text{ feet}$$

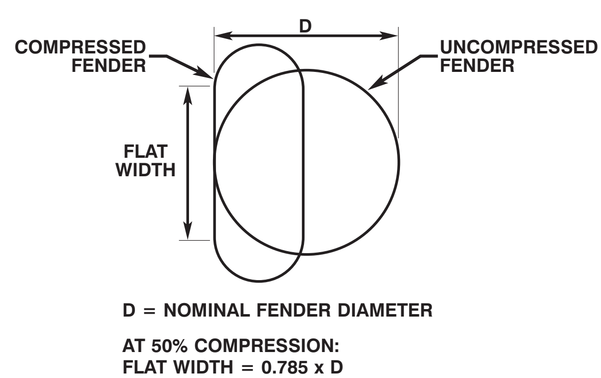


Figure 3-9. Fender at 50% Compression.

Table 3-2. Fender Array Selection Guide.

Size or Equivalent Size of Ships	Berthing Velocity	Effective Berthing Energy	Fender Array HP Pneumatic or Foam		Fender Array LP Pneumatic	
DWT	**ft/sec**	**tons**	**D×L feet**	**Minimum Number**	**D×L feet**	**Minimum Number**
1,000	1.00	3	3 × 6	3	4.5 × 13	3
3,000	1.00	8	4.5 × 9	3	6 × 20	3
6,000	1.00	14	6 × 11.5	3	7.5 × 26	3
10,000	0.82	15	6 × 11.5	3	7.5 × 26	3
25,000	0.82	37	8 × 18	3	9 × 40	3
50,000	0.66	46	8 × 18	4	9 × 40	3
100,000	0.50	49	11 × 15	4	10.5 × 40	3
200,000	0.50	93	11 × 21	4	9 × 52	3

Table 3-2 is a guide to determining the minimum fendering array for a particular operation based on the deadweight of the two ships and the berthing velocity. If the receiving ship is mooring alongside a ship that is heavily grounded, Table 3-2 may be entered with the deadweight of the receiving vessel alone. If both vessels are afloat or the casualty is lightly grounded, Table 3-2 must be entered with an equivalent size. The equivalent size is calculated by:

$$C = \frac{(2)(A)(B)}{(A+B)}$$

where:

C	=	equivalent size (tons)
A and B	=	the deadweights of the two ships (tons)

When the two ships are the same deadweight, $C = A = B$. If naval vessels are involved in the transfer and only displacements are known, displacements may be divided by 1.3 to obtain an approximate deadweight.

To keep berthing energy low, the berthing velocity should be kept low. The berthing velocities given in Table 3-2 are the maximum permissible. Note that as the size of the ships increases, the permissible berthing velocities decrease.

Table 3-2 is a guide to determining the minimum fender array for a particular operation. The specifications and guidance for the particular fenders should be checked to ensure the fenders actually provide the required energy absorption and stand-off. When suitability is questionable or marginal, and the situation permits, larger fenders should be substituted and fenders added to the array.

EXAMPLE 3-2
DETERMINATION OF FENDERING ARRAY

a. A 70,000-ton deadweight tanker is to be berthed alongside a heavily stranded 200,000-ton VLCC for transfer of a portion of the latter's cargo. What is the maximum berthing velocity, berthing energy, and minimum low-pressure pneumatic fender array?

70,000 tons falls between 50,000 tons and 100,000 tons in Table 4-2. Entering Table 4-2 with the higher value gives a maximum berthing velocity of 0.50 feet per second or about 0.30 knots, and a maximum berthing energy of 49 ft-tons.

From Table 4-2, the minimum low-pressure pneumatic fender array is:

3 fenders, 10.5 feet in diameter and 40 feet long

b. The same two tankers are to be berthed together, but the 200,000-ton VLCC is anchored following a fire that has burned out her engine room, accommodation, and pump room. What is the minimum high-pressure pneumatic fender array?

To determine the equivalent size:

$$C = \frac{(2 \times A \times B)}{(A + B)}$$

$$C = \frac{(2 \times 70{,}000 \times 200{,}000)}{(70{,}000 + 200{,}000)}$$

$$C = \frac{28{,}000{,}000{,}000}{270{,}000}$$

$$C = 103{,}704 \text{ tons}$$

Since the equivalent size is greater than 100,000, Table 4-2 is entered at 200,000 tons. The minimum high-pressure pneumatic fender array is:

4 fenders, 11 feet in diameter and 21 feet long

c. An AOR-1 Class ship with a displacement of 37,360 tons is to replace the 70,000-ton vessel alongside the anchored VLCC. What is the minimum high-pressure pneumatic fendering array?

To obtain an approximate deadweight, divide the AOR's displacement by 1.3:

$$A = \frac{37{,}360}{1.3}$$

$$A = 28{,}738 \text{ tons}$$

then:

$$C = \frac{(2 \times A \times B)}{(A + B)}$$

$$C = \frac{(2 \times 28{,}738 \times 200{,}000)}{(28{,}738 + 200{,}000)}$$

$$C = \frac{11{,}495{,}200{,}000}{228{,}738}$$

$$C = 50{,}255 \text{ tons}$$

Close enough to 50,000 for the fender array for 50,000 tons. The array for high-pressure pneumatic fenders is:

4 fenders, 8.2 feet in diameter and 18 feet long

Where more exact calculations are required, berthing energy may be calculated by:

$$E = \frac{(M)(V^2)}{g}$$

where:

E	=	berthing energy (ft-tons)
M	=	effective mass (tons), as described below
v	=	berthing velocity (ft/sec)
g	=	acceleration of gravity 32.2 ft/sec2

The effective mass is the **displacement** tonnage *(W)*—or 1.33 times the deadweight tonnage—of the ships plus the mass of the water carried along with the ship. The mass of the water may be calculated by:

$$A = (0.0225)(T^2)(L)$$

where:

A	=	the added mass of the water
T	=	draft
L	=	length between perpendiculars

therefore:

$$M = W + A$$

When two floating ships are berthed together, an equivalent mass, similar to the equivalent size discussed in conjunction with Table 4-2, must be calculated:

$$M_E = \frac{(M_1)((M_2))}{(M_1 + M_2)}$$

where:

M_E	=	equivalent effective mass
M_1 and M_2	=	effective masses of the two ships

Once the berthing energy is known, a suitable fender can be chosen from manufacturers' data. Manufacturers' data for fenders often gives berthing energy in foot-kips or meter-tonne. **Foot-kips** can be found by **multiplying** foot-tons by **2.24**. **Meter-tonne** may be found by **dividing** foot-tons by **3.33**.

EXAMPLE 3-3
CALCULATION OF BERTHING ENERGY

a. The 70,000 deadweight ton tanker in Example 3-2 is 700 feet long and draws 50 feet. What is the berthing energy if her berthing velocity is 0.50 feet per second?

$$\text{Displacement} = 1.33 \times \text{Deadweight}$$
$$\text{Displacement} = 1.33 \times 70{,}000$$
$$\text{Displacement}\ (\text{W}) = 93{,}100 \text{ tons}$$

$$A = 0.0225 \times T^2 \times L$$
$$A = 0.0225 \times (50)^2 \times 700$$
$$A = 39{,}375 \text{ tons}$$

$$M = W + A$$
$$M = 93{,}100 + 39{,}375$$
$$M = 132{,}475 \text{ tons}$$

$$E = M \times \frac{v^2}{g}$$
$$E = 132{,}475 \times \frac{0.50^2}{32.2}$$
$$E = 1{,}028 \text{ ft-tons}$$
$$E = 2{,}303 \text{ ft-kips}$$
$$E = 308 \text{ m-tonnes}$$

EXAMPLE 3-3 (CONTINUED)
CALCULATION OF BERTHING ENERGY

b. What is the berthing energy of the 70,000 deadweight ton tanker berthing alongside the 200,000 dwt VLCC if the latter's draft is 70 feet and her length 1,000 feet? The berthing velocity is 0.50 feet per second.

From part (a) M1 = 132,475 tons

For the 200,000-ton VLCC

$$\text{Displacement} = 1.33 \times \text{Deadweight}$$
$$\text{Displacement} = 1.33 \times 200{,}000$$
$$\text{Displacement}\ (\text{W}) = 266{,}000 \text{ tons}$$

$$A = 0.0225 \times T^2 \times L$$
$$A = 0.0225 \times (70)^2 \times 1{,}000$$
$$A = 110{,}250 \text{ tons}$$

$$M_2 = W + A$$
$$M_2 = 266{,}000 + 110{,}250$$
$$M_2 = 376{,}250 \text{ tons}$$
$$M_E = \frac{(M_1 \times M_2)}{(M_1 + M_2)}$$
$$M_E = \frac{(132{,}475 \times 376{,}250)}{(132{,}475 + 376{,}450)}$$
$$M_E = \frac{49{,}843{,}190{,}000}{508{,}925}$$
$$M_E = 97{,}939 \text{ tons}$$

$$E = M_E \times \frac{v^2}{g}$$
$$E = 97{,}939 \times \frac{0.50^2}{32.2}$$
$$E = 760 \text{ foot-tons}$$
$$E = 1{,}702 \text{ foot-kips}$$
$$E = 227.5 \text{ meter-tonnes}$$

3-4.3.2 Freeboard. Fenders float high in the water and respond to the sea more rapidly than the ships. The sea may throw fenders on deck or fenders may crawl up the side of the ship on repeated loading and incomplete relaxation. Fender diameter should be no more than half the minimum freeboard of either vessel. On damaged ships or warships with relatively low freeboard, the diameter of the fender relative to the freeboard can be a governing factor in fender selection. Low-pressure pneumatic fenders are a good choice when fender diameter is limited by freeboard. When freeboards are very low and fenders small enough to meet the freeboard requirement have inadequate energy absorption capacity, the salvage officer may choose a fender as large as 75 percent of the freeboard. Fenders this large are practical only in good weather and, if necessary, should be restrained against sea-induced motions. High pressure pneumatic fenders can be partially filled with water to reduce this motion, however the trade off is a loss of energy absorption.

3-4.3.3 Overhanging Structure. Overhanging structure that may come into contact with the other vessel at the maximum expected roll or heel must be protected. This protection can be provided in one of three ways:

- Large-diameter primary fenders that will increase the separation between the ships. This solution is practical only when there is enough freeboard to accommodate the larger fenders.

- Tertiary fenders on the overhanging structure when the overhanging structure is strong enough to withstand the fendering loads.

- Tertiary fenders placed at other points, such as along the deck edge.

When the casualty is listing, superstructure and fittings may extend farther from the side than on an upright ship, and may require more extensive protection than would otherwise be necessary.

3-4.3.4 Hull Strengths of the Ships. Fenders can transmit relatively high local loads to the shell plating of ships. Ideally, fenders are located at transverse bulkheads on each ship. This is seldom achievable in practice. The fenders should be located at transverse bulkheads on the ship upon which they are rigged. If either ship is lightly constructed, low-pressure pneumatic fenders that distribute loads over a large area should be chosen or additional fenders rigged. In the latter case, the capacity to accept higher berthing loads will not be increased, but the capacity to accept loads from the ships working in the seaway will. Berthing loads can be decreased by keeping the relative velocities between the ships low and carrying out the berthing operation in good weather.

3-4.4 Numbers and Arrangement of Fenders. Primary fenders are placed along the length of the parallel midbody of the smaller ship. One fender is placed at each end of the parallel midbody; the others are arrayed along the length in general conformance with the following:

- Two fender arrays are suitable only when the ships are 5,000 tons deadweight or less.

- Three or four fenders should be rigged with all larger ships. Four-fender arrangements are the most common.

- The distance between fenders should not exceed 100 feet.

- Fenders should be centered on the transverse bulkheads on the ship upon which they are rigged.

- Fender types may be mixed in the array.

Secondary fenders, usually single fenders, may be positioned at the bow and the stern of the receiving ship as required to accommodate misalignment during mooring or getting underway.

Fenders should be tended carefully during transfer operations. Secondary fenders should be adjusted to ensure there is no direct contact between the vessels as displacements and freeboards change. Fenders should not be removed or re-positioned until the operation is complete and the vessels are underway. In extremely hot weather, fenders should be cooled by spraying water on them.

Tertiary fenders are placed as necessary to protect overhangs, and should be tended while the ships are moored.

3-4.5 Rigging Fenders. Common ways to rig fenders include those described in Paragraphs 3-4.5.1 through 3-4.5.3. Whatever the method of rigging, the fender should be secured by two lines.

3-4.5.1 Rigging Fenders Individually. Fenders may be rigged on the receiving vessel with the assistance of shore or floating cranes when the ship is alongside a pier or in a harbor where floating crane services are available. This method is suitable with any ship and any size fenders. The fenders may be rigged in place over the side or may be stowed on deck and launched at the transfer site. In the first case, the receiving ship makes the transit to the transfer site with the fenders rigged. This method is not practical if a long transit is necessary, or if the weather is inclement. Launching at the salvage site requires that the ship have storage space on deck and cargo-handling gear for the launches. Launches are practical only in calm seas; launching large fenders in heavy seas is dangerous.

3-4.5.2 Handling Fenders with Special Davits. Lightering vessels that regularly make ship-to-ship transfers may be fitted with davits for rigging fenders. These vessels normally make their transfers with the same classes of vessels and are fitted with fendering systems designed for these particular transfers. If prerigged receiving ships are used as receiving ships for casualty operations and emergency transfers, it is often necessary to do considerable rerigging to suit the casualty. When the casualty occurs near a port from which fitted lightering ships operate, the salvage officer should investigate the possibility of chartering such a ship and should evaluate the amount of rerigging required.

3-4.5.3 Rigging Fenders from a Support Vessel. Fenders may be brought to the receiving ship and positioned individually by support vessels. Attached lines are passed aboard from the support vessel for securing. In most circumstances, the most practical method of rigging fenders is in a string aboard a support vessel and pass them to the casualty. An ARS, T-ATF, offshore supply vessel, or similar craft with a large, open working deck is very suitable for this work. Fenders may be rigged alongside either in port or in a sheltered area, and towed to the transfer site, or carried rigged on board the support vessel and launched at the site. When carried on deck, they may either be secured on deck or stacked in cradles built for the job. Figure 3-10 illustrates a cradle for a four-fender string. Launching procedures at the site vary with the support ship and equipment and must be compatible with the stowage. The fenders may either be lifted over the side and launched with a derrick or launched from the stern. In both cases, the fenders are brought alongside and hogged in tightly with securing lines passed through the wire nets, end fittings, or girthing lines until streamed for putting alongside the tanker.

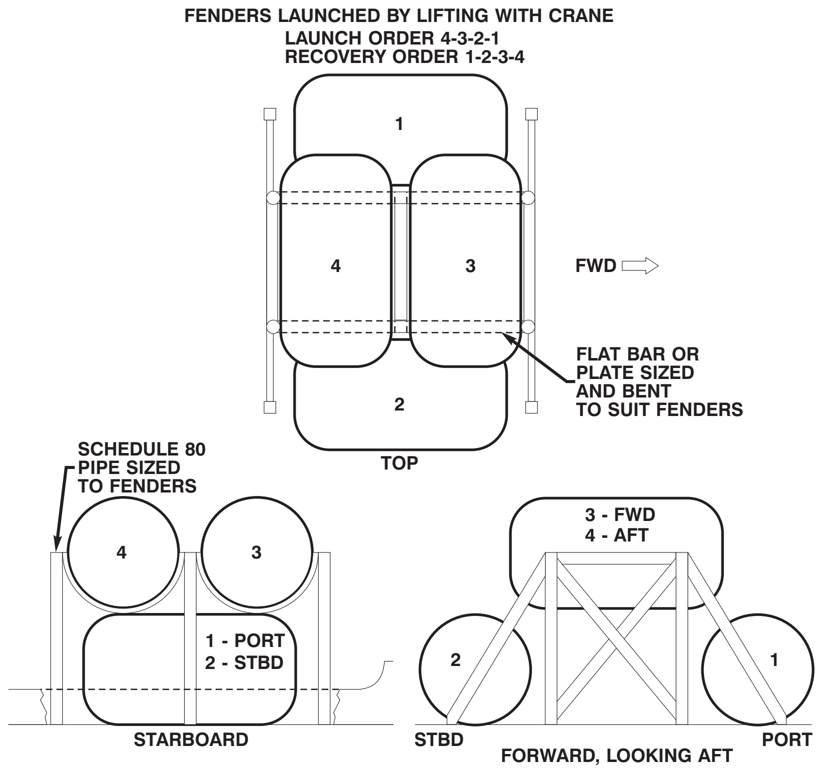


Figure 3-10. Cradle for Four-Fender String.

Figure 3-11 shows a typical string of fenders rigged for passing to a support vessel. Line lengths vary to suit the particular operation. A small tug or workboat is required to assist in handling and positioning the fenders. Fenders may be passed with the receiving ship anchored or underway at two to three knots.

The exact procedure for rigging and positioning fenders will depend upon the conditions at the site and the vessels conducting the operation. The general procedure is:

a. The headline and wire rope preventer of the forwardmost fender are passed to the tanker and secured with the fender in the correct position.

b. The fender is released by the support vessel.

c. The securing line for the second fender is released and the fender streamed.

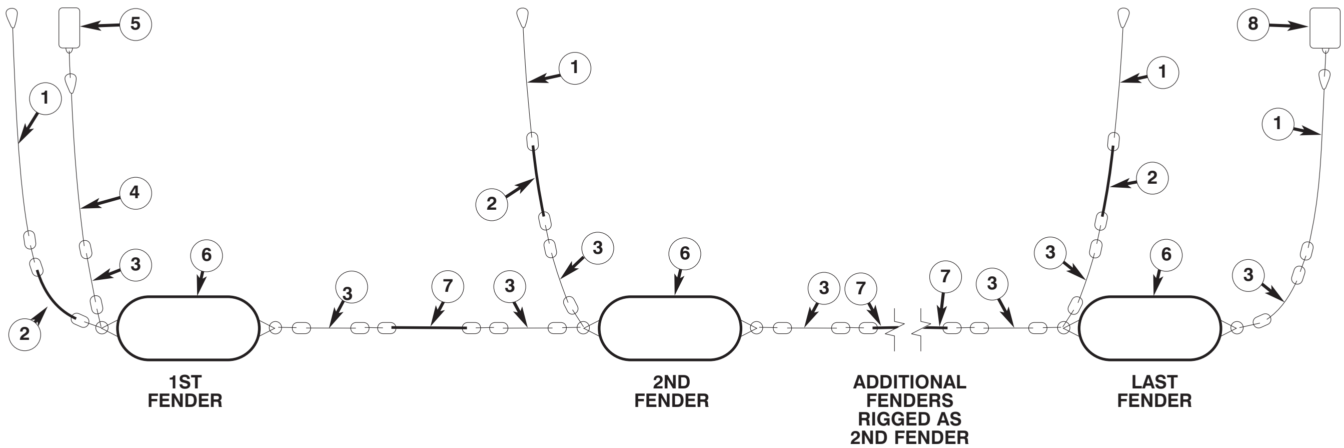
d. The second fender is picked up and positioned by the assisting craft.

e. The wire rope preventer is passed to the tanker and secured.

f. The fender is released by the assist craft.

g. Steps c through e are repeated until all fenders are in place.

After the transfer is complete and one ship is underway, fenders are recovered by the assist craft in the reverse order of placement, and brought alongside the support vessel where they are either brought on board or rigged for tow.



1. 1-1/4" WIRE ROPE WITH HARD EYE - SOFT EYE
2. 7" NYLON PENDANT WITH HARD EYES
3. 1" WIRE ROPE PENDANT WITH HARD EYES
4. 3" NYLON LINE WITH HARD EYE - SOFT EYE
5. RECOVERY BUOY
6. FENDER
7. 7" NYLON LINE WITH HARD EYES
8. PICK-UP BUOY

Figure 3-11. Typical Rigging for Fender String Passed by Support Vessel.

CHAPTER 4
SALVAGE OFFLOAD OF NON-CARGO OILS

4-1 INTRODUCTION.

Oil must often be removed from a casualty to achieve one or more effects:

- Reduce the immediate pollution potential.
- Eliminate the potential for pollution from casualties that are to be abandoned.
- Remove or redistribute weight in conjunction with salvage efforts.
- Recover the oil for its economic or military value.

Oil to be removed includes cargo oil, bunker fuel, and miscellaneous oils. Chapter 5 of this volume addresses this equipment and how it is employed in the emergency transfer of oil cargoes. This chapter addresses gaining access and removal of bunker fuel oils—a very different business. The ESSM system has developed several tools that can aid in the salvage of ship's bunkers, including special landing plates and Hot Tap devices. Many of the techniques that have been improvised and successful for removal of bunker fuels are not suitable for the removal of cargo oils. Gaining access to and removing bunker fuels requires:

- Selecting suitable equipment,
- Adapting equipment intended for other purposes, and
- Applying imagination, sound salvage judgement, good seamanship, and basic engineering principles.

There is no *recipe* for removing fuel oils in salvage. Each operation is different and must be thought through carefully.

WARNING

The techniques described in this chapter are strictly for removal of non-cargo oils and miscellaneous oils.

4-2 TANK ACCESS.

Obtaining access to the tank in a way that precludes or minimizes pollution is the first step in removing oil. Oil tanks in ships have a small number of standard openings that are described in Paragraph 2-2.1.1. These openings may be a means of entry into the tank. The choice of the method of oil removal will depend on the access that is most practical. The position of the ship and the location of tank fittings, in turn, determines the access points. In some cases, particularly when ships are capsized or inverted, it may not be practical to enter the tanks through any of the existing accesses. *Hot tapping*—a technique developed in the oil fields to enter flowing pipelines—has been adapted to salvage and has been successful in oil removal operations.

4-2.1 Piping. Transfer and suction piping is the most desirable tank access for oil removal. If the casualty's transfer pumps can be placed in operation and the oil can be removed through the normal defueling system to the deck connections, it should be. If the system is degraded, operable components should be used. Transfer piping may be broken at any convenient flange—such as those on tank manifolds—and portable pumps rigged. Pump discharges may be rigged either back into sound transfer system piping or directly to the receiving vessel. The details of the system used depend upon the configuration and condition of the casualty, but access through installed piping systems should always be considered first.

4-2.2 Tank Fittings. If it is impractical to remove oil through the installed piping system, the second choice is the fittings and lines that are installed in the tank. Removal of fuel through these fittings is common in salvage operations.

4-2.2.1 Vents and Sounding Tubes. Vents and sounding tubes are suitable for inserting hoses for pumping, blowing or water displacement, or for natural flows of water or air to replace oil removed from the tank. Vent and sounding tube terminations have the particular advantages of being located remotely from the tank and not requiring access to the shell of the tank itself. Upper vent terminations have the additional advantage of being located on weather decks; entry into the ship is not required to reach them. In the tanks, vents terminate at the upper tank boundary, so a hose must be run through the vent to reach the bottom of the tank. Sounding tubes run near the bottom of the tank, but are often perforated to ensure the liquid level is the same inside and outside the tube. It is good practice to run a hose through sounding tubes. Vents are larger and can accommodate a larger hose. Figures 4-8 through 4-12 in Section 4-3 illustrate several means of accessing tanks through vents and sounding tubes.

4-2.2.2 Overflows. Overflows are not a good means of access to fuel oil in tanks. Overflow piping generally runs from the fuel tank to another tank in the ship and contains check valves, alarm sensors, and other obstructions that make passing lines through it difficult.

4-2.2.3 Manholes. If tanks are to be pumped with submersible pumps, they must be accessed through the manhole, as it is the only opening large enough to pass the pumps. In many casualties, tank manholes will be inaccessible because of cargo or other material above them that block access. Manholes must not only be accessible, but there must be enough room around them to handle and rig pumps. To prevent the escape of fumes and the development of fume concentrations, manholes must be closed around the hose with sheet rubber gaskets, plastic bags filled with sawdust or water, or some similar means. Pump prime movers should be located in a well-ventilated area clear of probable fume accumulations.

4-2.2.4 Keel Plugs. Tanks on the bottom of the ship normally have keel plugs near their low point. Keel plugs are 1½- to 2-inch steel threaded plugs placed in holes in the bottom of tanks to allow the tank to be drained in drydock. The plugs are removed from the outside. They have recessed hexagonal heads for removal with a special tool that fits the head like an allen wrench. The tool is made so the plug may be started with a slugging hammer or a wrench. Special tools for keel plugs may be in the ship, but it is usually quicker and easier to make a tool in the field than to find one. Keel plugs are an excellent tank access when the casualty is inverted or nearly so.

WARNING

Hot tap cutting produces sparks and heat and may ignite flammable vapors within the tank. To prevent explosion, Hot Taps must be positioned well below the oil-air interface.

4-2.3 Hot Taps. Hot Taps cut through the oil container with an extendable rotary cutter enclosed in a watertight and oil tight cylinder and operated through an open gate valve. When the cut is completed, the cutter is withdrawn through the valve, the valve closed, and the cutter replaced with a hose, pipe, or other means of carrying the oil away. Hot Taps were developed in the oil field to enter flowing pipelines without interrupting the flow or spilling the flowing fluid. Salvage Hot Tap machines—basic oil field Hot Taps modified for salvage—are available in the ESSM System, which has both heavy- and light-weight Hot Taps. The *poor man's Hot Tap* is a field improvisation that has been used for entering otherwise inaccessible tanks when a small spillage of oil is acceptable or is, by a significant margin, less of a threat than the oil in the ship.

The heavy-weight Hot Tap machine may be operated in any position, but because of its weight of about 260 pounds in air, it must be handled with cranes, foam flotation, or lift bags to position it perpendicularly to the hull. These restrictions do not apply to the light-weight Hot Tap machine.

The cut must be made well below the oil-air interface and clear of internal structural members. The position of these members may be determined by checking the ship's structural plans and measuring the location on the hull, examining the hull for the lines of structural members, or tapping the hull with a hammer. The latter method is the most reliable, applicable in all cases, and a sound backup for other methods.

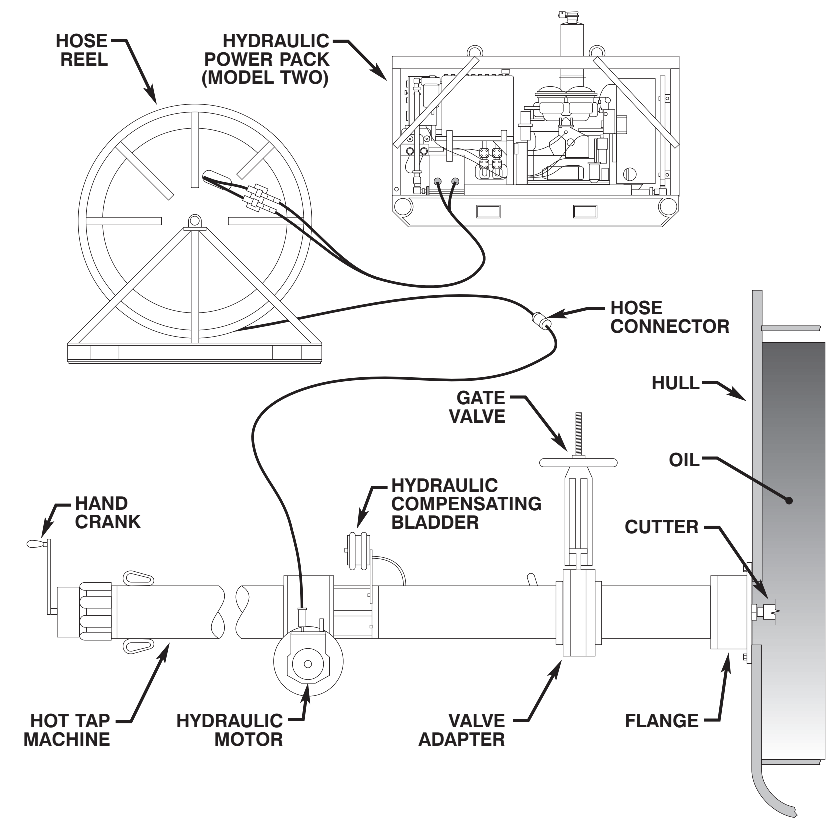


Figure 4-1. Salvage Hot Tap Equipment.

4-2.3.1 Salvage Hot Tapping. The ESSM salvage Hot Tap equipment is a pneumatically or hydraulically driven cutter capable of cutting a nominal 6-inch diameter hole in 1-inch-thick mild steel plate in any position.

Specifications for the system are found in Appendix C.

The system consists of:

- Power source.
- Hose assemblies.
- Hot Tap machine.
- Motor.
- Valve adapters.
- Gate valve.
- Flange adapters.
- Cutters, cutter holders, and pilots.

Figure 4-1 shows the basic Hot Tap equipment. The power source for the Hot Tap may be the Hydraulic Power Source Model 2 or another power source capable of supplying 15 gpm at 1,500 psi, or an air compressor capable of at least 105 cfm at 90-100 psi over ambient pressure at the motor. The cutter head is equipped with a 1¼ -inch pilot and recessed detentes or barbs that hold the cut piece so it may be lifted from the hole. The rate of travel of the cutter may be adjusted manually from 0 to ⅛-inch per revolution. Rates of travel may be adjusted by trial and error on the job. Figure 4-2 shows the Hot Tap machine and cutter details.

Setting a salvage Hot Tap requires the following steps:

a. Ensure that oil is completely pressed to the top of the tank and no headspace is present.

b. The surface in way of the installation is cleaned.

c. Appropriate sized flange or studs are welded to the tank top (studs may also be shot or drilled and tapped into the hull plate).

d. A gate valve is installed over the welded flange. When using studs, a flange and valve adapter must be fitted first.

e. The Hot Tap assembly and Hot Tap machine is set in place and secured. Alternatively, the components may be assembled in place. If the assembly is not vertical, it should be supported by a lift bag or crane to minimize side loads on the studs.

f. Power leads are made up to the Hot Tap machine motor.

g. The gate valve is checked to be sure it is completely open.

h. The cutter head is cranked down against the hull by the hand crank located on the end of the Hot Tap machine.

i. Power is cut into the motor.

j. When the hull is penetrated, the cutter with the cut piece is withdrawn through the valve by the hand crank.

k. The valve is closed.

l. The Hot Tap machine is removed from the gate valve and replaced with a hose or elbow and hose.

The Hot Tap machine may be operated in any position, but because of its weight of about 260 pounds in air it must be handled with cranes, foam flotation, or lift bags to position it perpendicular to the hull.

The cut must be made well below the oil-air interface and clear of internal structural members. The position of these members may be determined by checking the ship's structural plans and measuring the location on the hull, examining the hull for the lines of structural members, or tapping the hull with a hammer. The latter method is the most reliable, applicable in all cases, and a sound backup for other methods.

4-2.3.2 Lightweight Hot Tap System. The Lightweight Hot Tap System is a small universal Hot Tap capable of operating within the confines of a vessel both above and below water. System components all weigh less than 35 pounds each and are easily handled in restricted vessel spaces. Powered by a small hydraulic drill operating from the Model 9 Hydraulic Power Unit, the system is capable of drilling holes up to 6 inched in diameter through 1-inch mild steel plate. The attachment flange is fastened to the hull using self-tapping bolts. The boring tool, the Hot Tap, passes through a valve assembly on the flange and penetrates the hull. The cutting head is extracted back through the valve, the valve is closed and the Hot Tap machine is removed. Hoses, Pumps, probes, and other devices may be attached to the flange/valve assembly and the tanks emptied.

4-2.3.2.1 Lightweight Hot Tap Operation. The Lightweight Hot Tap System is designed for tapping in mild steel hull plating up to 1-inch thick. The Hot Tap machine has the capability of tapping a 5½-inch hole through a 6-inch knife valve. However, the most practical size of Tap is either a 2⅝-inch hole through a 3-inch full port ball valve or a 3⅝-inch hole through a 4-inch full port valve.

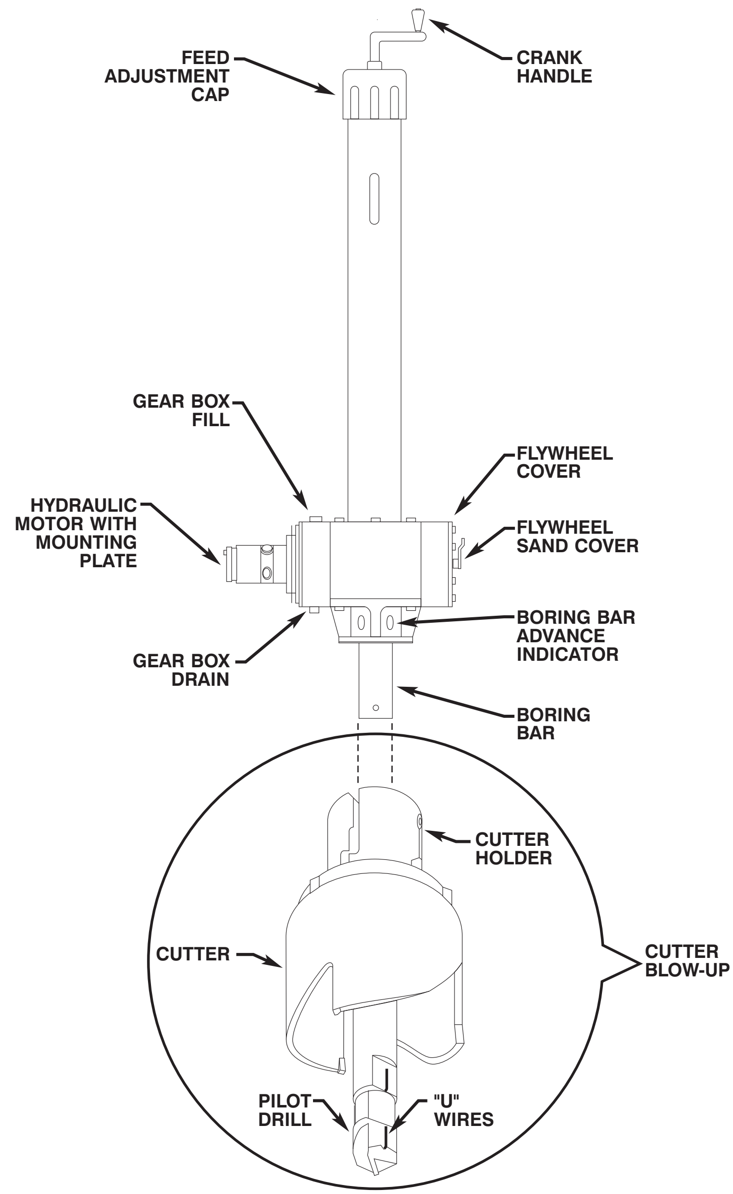


Figure 4-2. Salvage Hot Tap Machine and Cutter.

The flange/valve assembly, through which the Tap is accomplished, is available in two configurations: a flat surface plate and a contour forming plate. The flat plate is 12 inches in diameter with a 12-bolt hole pattern on a 10-inch bolt circle. This plate is used for flat shell or tank top applications. The contour forming plate has a 12-inch by 4-inch base with serrated tabs perpendicular to the base. These tabs can be formed to the contour of the hull.

The flange assembly is attached to the hull using self-drilling/tapping hex head bolts driven by a hydraulically operated DL 9 drill. Other drills may be used in different operations. However, the hydraulic drill allows for use underwater.

A Model 9 Hydraulic Power (2,000-psi, 12-gpm) unit is used to drive the drill. This same power unit and drill also drive the Hot Tap Tool.

The flange is attached to the hull independently and the valve is installed after attachment. Magnetic support systems are supplied to assist in holding the flange/valve assembly in place for drilling.

Attaching the flange requires the following steps:

a. Select the area to be Hot Tapped using the following criteria:

- The area should be relatively flat, not overly wash boarded, and provide enough space to operate the Hot Tap. Take into consideration the surrounding space, and allow for a pump and hose that may need to be attached.
- The hull plating must not be more than 1-inch thick and of mild steel.

b. After locating the area on the tank to be tapped, sound the area with a hammer to locate any hard spots that may interfere with the flange attachment, such as frames and doublers. You only want to drill through the shell plate, not into a frame or doublers.

c. Thoroughly clean the area in which the flange will be attached. Remove all floor coverings, terrarazo, barnacles, and loose paint, and scrape or wire brush the steel surface to create a smooth surface that will allow the gasket to seal.

d. Flanges are painted white so they stand out against darker surfaces. If the hull section is white, you may want to paint the flange a different color. Once the flange is the right color, glue the gasket to the flange (this step can be done earlier so the glue is dry when you are ready to attach the flange).

e. Prepare the bolts. Wrap the 5/16-inch self-tapping bolts with Teflon tape on the thread portion of the bolt. Wrap by holding the free end of the tape over the top of the bolt and turning the bolt by hand as if you were tightening it. Two wraps are sufficient. Place an O-ring over each bolt and slide it all the way up to the head.

f. Set up the Model 9 Hydraulic Power Unit (HPU) and connect the drill. Bolt driving usually requires 2,000 psi and 5 gpm from the HPU. If you are using another HPU, place the Flow Restrictor that is provided with the drill inline on the inlet side of the drill.

g. Using the 5/16-inch self-tapping bolts and the flange/valve assembly as a template, bolt the flange to the hull plate. For a flat flange, you must drive at least 6 bolts, equally spaced around the flange. For a contour flange, at least 8 bolts are required – 6 in the solid wings and at least 1 in each of the remaining serrated wings.

Note: The contour flange can be pre-bent to the contour using the provided contour gage to establish the required bend radius. The flange can be hammered into the approximate contour and then pulled to the final shape with the bolts.

Drive the bolts with the drill until the gasket compresses slightly. A lever arm drill press that uses a high strength magnet as the pivot point is provided to assist in the drilling operation. A constant moderate pressure is required on the self-tapping bolts. Practice this operation on a sacrificial plate beforehand to get the feel. *Do not over tighten the bolts with the drill.* Using the torque wrench, torque all bolts to 15 foot pounds using a diagonally opposing pattern.

WARNING

On tanks that are "pressed" or under pressure, always drive the bolts through the gasket material, as it will disperse the air or spray that will escape when the bolt penetrates. The operator must wear protective clothing and face protection when attaching a flange to a pressurized tank.

The Hot Tap Machine is a small unit that attaches to the flange/valve assembly using Cam Lock fittings. The drill drives the pilot bit and cutter head, and the feed is controlled manually using the handles on the Hot Tap. The Tap is accomplished through the open valve; when the hole is completed, the cutter is extracted by turning the handles counter clockwise. The pilot bit retains the coupon (hole center). The valve is closed before disconnecting the Hot Tap from the flange/valve assembly.

Hoses, pumps, probes, air and other tools may be attached to the valve assembly 3-inch male camlock fitting for offload operations.

Setting up a lightweight Hot Tap requires the following steps:

a. Read the instructions in the Hot Tap Kit. They are fairly concise, but need amplification from lessons learned.

b. Select the size cutter to be used. The 2 5/8-inch cutter is the largest that will safely pass through the 3-inch valve. Attach the pilot bit to be used. These bits have a coupon retaining wire in the end.

c. Attach the pilot bit and cutter head to the boring bar, making sure that all threads are coated with non-permanent Lock tite and are tight. The pilot bit must extend a sufficient distance beyond the cutter to fully penetrate the plate and retain the coupon. Verify that the pilot bit is extended sufficiently by placing a straightedge across the teeth of the blade and ensuring that the small coupon retaining wire projects beyond the edge of the cutting teeth.

d. Retract the boring bar to its full out position. After verifying that the Teflon camlock gasket is in place, position the Hot Tap assembly over the camlock fitting on the attached flange/valve assembly. Dog the camlocks down and lock them in place with the pins that are attached.

e. Fully open the ball valve. Using the handles on the Hot Tap, screw the boring bar in until the pilot drill hits the vessel or tank shell plating. Back off at least one complete turn to take the bit away from the shell plate.

f. Start the HPU; set the pressure to 2,000 psi and the flowrate to 6 gpm.

g. Using the deep-well socket attachment on the drill, attach the drill to the drive end of the Hot Tap.

h. Start the drill and slowly advance the pilot drill/cutter into the hull by turning the Hot Tap Handles clockwise. Advance the cutter slowly (you will feel the pilot bit break through).

i. Once you are sure that the pilot bit has broken through, stop the drill and feed the cutter until the cutter stops at the hull plate. Back off 1 turn and start drilling again, feeding slowly as the cutter engages the hull (drilling requires a "feel" of the cutter's progress).

Note: If the cutter binds, stop the drill, back the cutter out a turn, and start again.

j. When you feel the cutter break through, keep feeding the cutter for at least 15 seconds to make sure you are all the way through. The cutter advance should be easy at this point.

k. Remove the drill from the shaft and back the cutter all the way out by turning the Hot Tap Handles counter clockwise until they can go no further.

l. Close the valve.

m. Remove the Hot Tap and attach fittings, hoses, and pumps as required.

4-2.3.3 Poor Man's Hot Tap. The poor man's Hot Tap is a field improvisation to gain access to tanks and set up an oil removal system when no other methods are possible and a small underwater release of oil can be tolerated. The material required for setting the system is:

- Drilled and tapped, welded, or explosively set studs with matching nuts.
- A short 2-inch pipe spool piece with a flange that matches the studs on one end and a 2-inch bronze gate valve on the other. As shown in Figure 4-3, the flange must be broad enough to allow power-actuated studs to be fired as nearly vertically as possible and to give stability at the spool piece-hull interface. A rubber gasket cemented to the base of the spool piece provides a seal between the spool piece and the hull. Before the spool piece is set, the gasket should be immersed in the oil to be pumped to be sure the oil does not attack and destroy the gasket material.

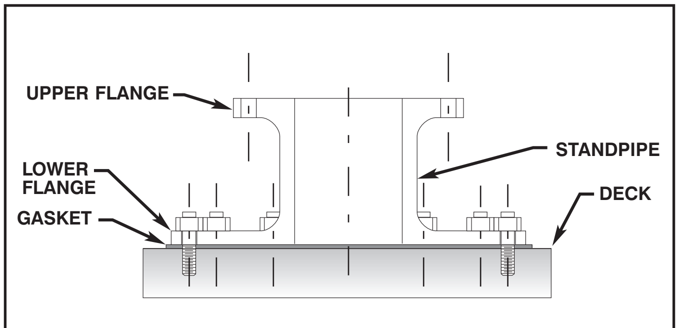


Figure 4-3. Spool Piece with Wide Flange for Hot Tapping.

- An oxyarc cutting rig, or a powered drill with a bit long enough to reach through the valve and spool piece and drill a hole through the hull.
- A second short spool piece to fit onto the valve and to attach to a hose, preferably by a Cam-Lok fitting, made up to the free end.

Setting a poor man's Hot Tap requires the following steps:

a. The surface in way of the installation is cleaned.

b. The location of the studs to match the flange are marked.

c. The studs are welded, drilled and tapped, or shot into the hull plate.

d. The gasket, flange, spool piece, and gate valve with the valve open are set in place either individually or as an assembly.

e. A hole is drilled in the hull or blown through it with oxyarc cutting equipment working through the open valve.

f. When the hole is through the hull the tool is withdrawn and the valve closed.

g. The second spool piece and hose is fitted to the valve and the hose rigged for oil removal. The Cam-Lok fitting on the hose connection is wired closed

Figure 4-4 illustrates the poor man's Hot Tap.

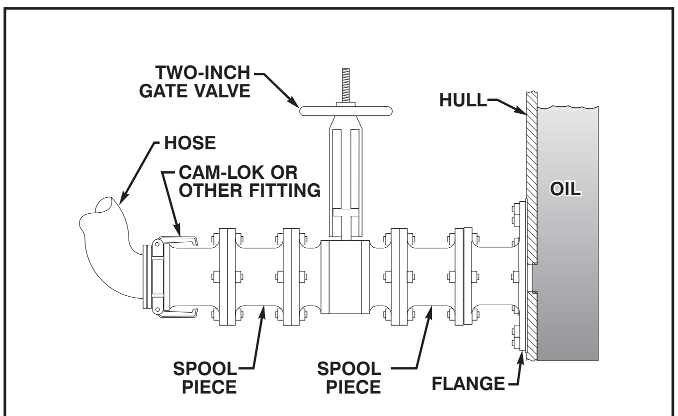


Figure 4-4. Poor Man's Hot Tap.

Tank entry with a poor man's Hot Tap should always be made well below the oil-air interface. The location of the interface may be confirmed by drilling the hull, confirming that the discharge is in fact oil, and plugging the hole. As with the salvage Hot Tap, entry must be made clear of internal structural members. The location of structural members may be determined in the same ways as described for the salvage Hot Tap.

The pipe and valves in a poor man's Hot Taps may be larger than the 2-inch size specified above. ESSM has used 3-inch and 4-inch aluminum valves with no problems.

Upon conclusion of Hot Tap operations, the spool pieces attached to the hull should be blanked to ensure that no residue in the tanks will escape.

4-2.4 Cutting or Chipping. Under some conditions, the most practical way of entering a tank may be by cutting an access. Exothermic cutting, sawing, drilling or chipping are all possible.

A tank should never be entered by exothermic cutting if there is any possibility that the plate being cut is backed by fumes or explosive vapors. Oil-backed plate can be cut exothermically. The depth below the surface of the oil at which a cut may be made safely in an oil-backed plate depends upon the type of oil in the tank. Technical advice from the Supervisor of Salvage should be obtained before cutting oil-backed plate exothermically. Water-backed plate in the lowest parts of tanks may be cut safely.

Oil-, water-, or air-backed plate may be cut mechanically by chipping, sawing, or drilling. There is a danger of sparking in cutting steel plate mechanically. The danger of sparking can be reduced by flooding the area being cut and cutting through a water blanket.

4.2.5 Water Injection System. The U.S. Navy Supervisor of Salvage in cooperation with the U.S. Coast Guard, Oil Spill Response Organizations, and a number of pump suppliers and manufacturers developed a prototype viscous oil pumping system (VOPS) in response to problems encountered during the salvage of the NEW CARISSA. The ESSM viscous oil pumping and offloading system is a water-injected annulus flange mounted on the discharge end of a Desmi DOP-250 positive displacement screw pump. The annulus delivers a small amount of water at high pressure into the oil stream. This creates a water ring that reduces the friction between the oil and the hose wall. The reduction in friction decreases the extreme pressure loss encountered during lightering operations involving viscous oils.

During testing, the water injection system transferred #6 fuel oil over ¼ of a mile through a 6-inch hose system. The test met the targeted flow rate of 450 gallons per minute with a system pressure of 90 psi. Without the use of the water injection system, the system would have had to overcome a pressure head of 870 psi in order to yield the same result. The success of the system has had implication on the removal of lighter oils as well. Since the discharge pressure in the system has been reduced, viscous oils can be pumped longer distances. All three Coast Guard Strike Teams are outfitted with the system and trained personnel are ready for deployment on request. ESSM also has one system ready for deployment.

Residual oils, such as #6 Oil, may require a water injection system and a screw pump to transfer the oil. This will be especially true in cold weather operations when the fuel oil or cargo has cooled below 50°F.

4-3 METHODS OF REMOVING OIL.

WARNING

Following oil removal, empty tanks will contain flammable vapor. If sufficient air is drawn into the tank, or the vapors are expelled from the tank by heat expansion or other means, explosive atmospheres will be created in tanks and near tank openings. Hot work, open flames, and spark sources are not permitted in the vicinity of empty tanks until they have been declared gas-free.

4-3.1 Pumping. Pumping is the primary method of removing oil from casualties. Pumps for handling fuel must be intrinsically safe and have no possibility of igniting the fuel or its vapors. If the ship's installed pumps are serviceable, or can be either restored to service or rigged with a safe emergency method, they are the first choice for pumping flammable liquids. If the installed pumps cannot be rigged satisfactorily, portable hydraulic, electric, steam, or pneumatic pumps may be used. *Flammable liquids should* ***not*** *be pumped with diesel- or gasoline-driven pumps.* Gasoline- or diesel-driven prime movers for hydraulic or electric pumps, or air compressors, and steam generators for steam pumps should be sited well clear of any concentration of fuels or potentially explosive vapors. They should always be in the open where eddys are not likely to carry explosive vapors.

In so far as is known, air lifts have not been successful in removing oils.

4-3.1.1 Installed Pumps. Pumps installed for the transfer of fuels and other oil are the first choice for removing these liquids from casualties. Quite often these pumps and their associated systems are inoperable because there is no power available on the ship or because piping is broken. They may be made operable by restoring the ship's steam or electric power, bringing in power from portable sources or by rigging hose or pipe jumpers around damaged pipe sections. The work and probability of success in restoring inoperative systems must be weighed against similar factors for portable pumping systems.

4-3.1.2 Hydraulic Submersible Pumps. The ESSM system has several modern, high capacity pumps that are purposely designed for salvage operations. These pumps are listed in Table 4-1. Many of these pumps are consolidated in ESSM System No. P17200, the 2-Inch to 6-Inch Submersible Hydraulic Pumping System. This system contains a variety of centrifugal and Archimedean pumps that can be used for transferring water or oils with a wide range of viscosities.

The CCN-150 (ESSM No. PU0280) 6-inch hydraulic submersible pump is a low viscosity oil offloading and dewatering pump that has been in the ESSM system since the 1970s. The ESSM system also contains a smaller number of the CCN-150 3C pumps (ESSM No. PU0290), which are an improved version of the CCN-150. The CCN-150-3C version has more durable seals and a higher capacity than the CCN-150. It also weighs approximately 180 lb vs. 280 lb for the larger CCN-150.

The more modern and higher capacity pumps located within the ESSM system include the Fischcon Salvage Pump (ESSM No. PU0295), which is a high volume, submersible, centrifugal, hydraulic pump designed for rapid water transfer (ballasting or dewatering) in a salvage operation.

For oil transfer or general water transfer, the KMA 333 (ESSM No. PU0310) is the optimal pump. It produces higher capacity and more head pressure than the CCN-150-3C, but is about the same weight. Centrifugal pumps will decrease in capacity as oil viscosity increases. The maximum oil viscosity that the oil rated centrifugal pumps should handle is around 8,000 to 12,000 cSt (equivalent to #6 Bunker Oil at 60°F to 70°F.

For any oil pumping that involves colder bunker oil, viscous crude oil, or crude oil emulsions, the ESSM system has two primary Archimedean screw pumps that should be used. The Desmi DOP-250 (ESSM No. PU0850) screw pump is a high-torque viscous oil transfer pump that can be used with almost any oil types or water-in-oil emulsions that could be encountered in salvage operations. It is too large to fit through a "Butterworth" hatch, but will fit through most manway size openings. The pump is capable of pumping oil of very high viscosity at flow rates of 440 gpm while developing simultaneous head pressures of up to 150 psig. This pump can be combined with the ESSM Viscous Oil Pump System (VOPS) kit, which introduces a small amount of water lubricant into the discharge of the pump to increase pumping distance capability and drop head pressure by factors of 10-to-1 or more.

Table 4-1. ESSM System Primary Hydraulic Submersible Offloading and Salvage Pumps.

ESSM No.	Pump Description	Primary Function	Power Required at Maximum Capacity	Maximum Flow Rate (gpm)	Maximum Head Pressure (psi)
PU0280	Kaeverner CCN-150, 6-inch, Submersible, Centrifugal, Hydraulic, 279 lb	Low Volume, Oil or Water Best on Low Viscosity Oil	52 gpm 2,300 psi	1,900	80
PU0290	Kaeverner CCN-150-3C, 6-inch, Submersible, Centrifugal, Salvage, Hydraulic, 200 lb	High Volume, Oil or Water Offloading Low Viscosity Oil	52 gpm 2,500 psi	2,100	80
PU0295	Fischcon, 6-inch, Submersible, Salvage, Hydraulic, 268 lb	High Volume, Dewatering Only	72 gpm 4,000 psi	2,800	115
PU0305	Hydra-Tech S4SCR, 4-inch, Submersible, Centrifugal, Hydraulic, 62 lb	Medium Volume, Medium to Light Oil or Water	15 gpm 3,500 psi	1,150	87
PU0310	MPC KMA 333, 6-inch, Submersible, Centrifugal, Salvage, Hydraulic, 210 lb	High Volume, Oil or Water Offloading Low Viscosity Oil	70 gpm 4,000 psi	2,300	117
PU0835	Hydra-Tech S2TAL-2, 2-inch, Submersible, Centrifugal, Hydraulic, 18 lb	Low Volume, Medium to Light Oil and Water	5 gpm 2,500 psi	180	54
PU0840	Desmi DOP-160, 3-inch, Submersible, Archimedean, Screw, Hydraulic, 75 lb	Low Volume, Viscous Oil	21 gpm 3,500 psi	120	150
PU0850 PU0851	Desmi DOP-250, 6-inch, Submersible, Archimedean, Screw, Hydraulic, 220 lb	Medium Volume, Viscous Oil	42 gpm 3,500 psi	440	150

The Desmi DOP-160 (ESSM No. PU0840) is a smaller version of the DOP-250. It weighs approximately 75 lb vs 220 lb for the larger DOP-250. Its capacity is only 120 gpm, but it has very high torque characteristics and can handle oils of viscosities over 200,000 cSt. This pump can also be combined with Annular Water Injection to increase pumping distance or enhance higher viscosity oil transfer.

Pumps for use in underwater work or areas where weight is critical would include the Hydra-Tech (HT) 4-inch and 2-inch submersible centrifugal pumps (ESSM Nos. PU0305 and PU0835, respectively). The HT 4-inch centrifugal pump can handle light viscosity oil and water up to 1,150 gpm or up to head pressures of 87 psig. This pump is ideal for use in scenarios that require a light weight pump or a pump for use in a small space, and is an ideal choice for use with the ESSM Lightweight Hot Tap System. This pump weighs 62 pounds. The 2-inch HT pump can handle water and light oil up to 180 gpm and weighs only 18 pounds.

4-3.1.4 Other Submersible Pumps. The 4-inch hydraulic submersible trash pump, available in the ESSM system, and commercial pneumatic submersible pumps are not specifically designed for pumping POL, but may be used in this service. Their efficiency and their output is less when they pump POL than when they pump water. The comments of the preceding paragraphs relative to placing the tanks through manholes, closing the access against fume leakage and locating the prime movers in fume-free areas apply.

4-3.1.5 Reciprocating Pumps. There are no reciprocating steam or pneumatic pumps designed for use in pumping oil from casualties. However, these pumps are often found in other shipboard and shoreside services, and may be used as portable pumps for pumping fuels. Steam pumps may be powered by the ship's steam generator, a portable steam generator, or compressed air. Pumps powered by compressed air will pump slower and less efficiently than the same pumps powered by steam. The air or steam pressure supplied to the

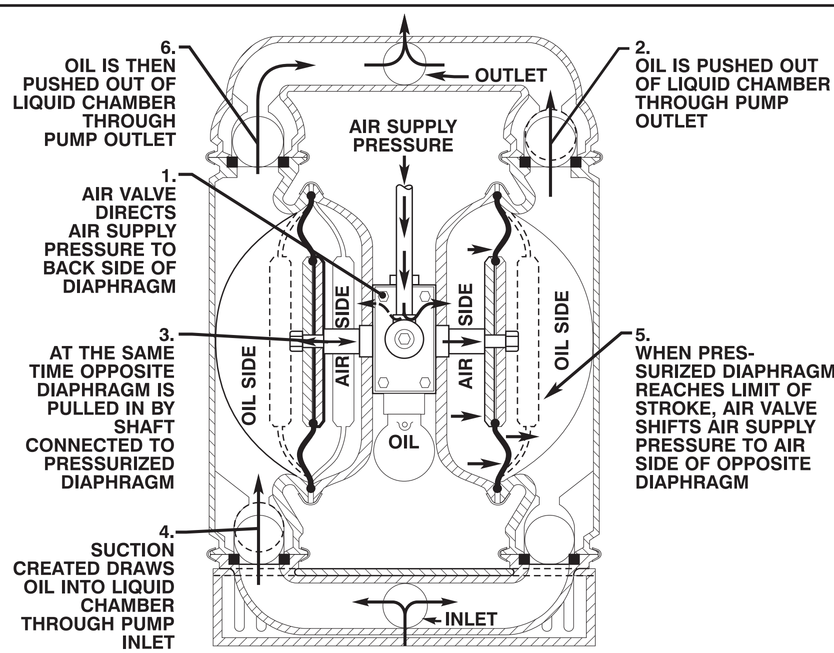


Figure 4-5. Pneumatic Double-diaphragm Pump.

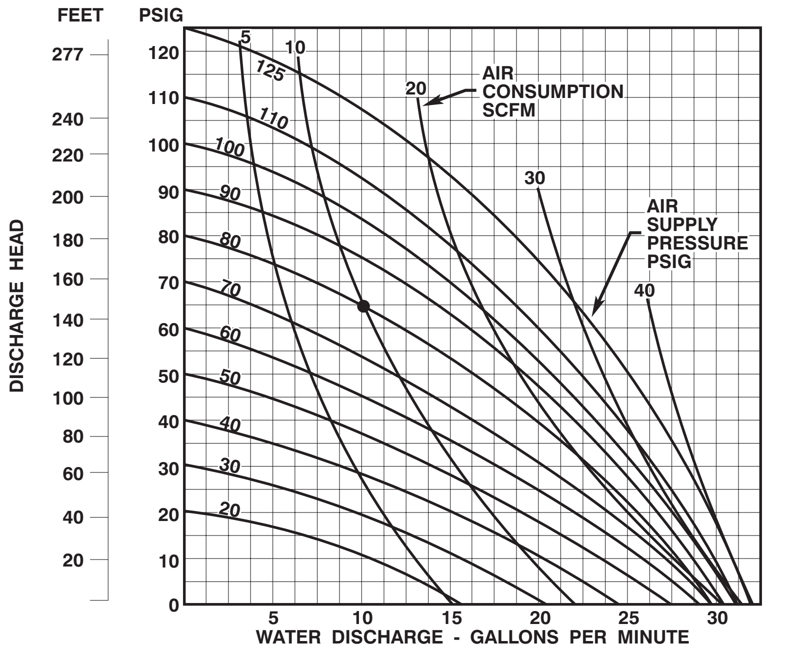
4-3.1.3 Electric Submersible Pumps. Fuels in casualties may be offloaded with the modified Prosser 4-inch electric submersible pump. This pump is available in the ESSM System and is issued to salvage ships and units. Only the modified pump is provided with impellers suitable for pumping POL. Appendix C contains detailed information on this pump and performance curves for POL service. As is the case with the 6-inch hydraulic submersible, because of its size the 4-inch electric pump must be put into fuel tanks through the manhole and the access closed around the hose and power leads to minimize the escape of fumes. Diesel-driven generators supplying power to electric submersible pumps must be located well clear of areas where fuel fumes are likely to collect. When the Prosser electric submersible pump is pumping POL, the rotation of the pump must be in the correct direction or the pump will burn out quickly. When the pump is running backwards, there is enough discharge to mask the improper operation. To check the rotation, remove the strainer and momentarily energize the pump. Rotation should be counter-clockwise when viewed from the suction end. If rotation is correct, replace the strainer and continue the operation. If rotation is not correct, reverse any two power leads and check the rotation again.

driving end of the reciprocating pumps should never exceed the design pressure of the pump. Overpressure normally causes the packing to blow out of the pump, but the danger of catastrophic failure of the pump casing is always present.

Reciprocating pumps are suitable for pumping fuel tanks through hoses inserted through any of the fittings or as booster pumps in manifolded systems.

4-3.1.6 Pneumatic Double-diaphragm Pumps. Pneumatic double-diaphragm pumps are excellent machines for pumping fuel from casualties. These positive displacement pumps are simple, reliable, quiet, suitable for liquids of all viscosities, and present no explosion hazard. They may be operated submerged and in self-priming, dry-starting arrangements with suction lifts up to 25 feet. Figure 4-5 illustrates the pump and its principles of operation. Output is varied by adjusting the volume or pressure of the air supply to the pump.

Figures 4-6 and 4-7 are performance curves for two common sizes of pneumatic double-diaphragm pumps. Performance data for specific pumps are available from the manufacturer and should be supplied with the pump.



HEIGHT	10' 1/2"
WIDTH	10' 1/2"
DEPTH	7"
WEIGHT	
(ALUMINUM)	22 LBS
(STAINLESS/HASTELLOY)	35 LBS
AIR INLET	1/4" NPT
INLET	1" MALE NPT
OUTLET	3/4" MALE NPT
SUCTION LIFT	18' DRY
	25' WET
MAX. SIZE SOLIDS	1/8" DIA

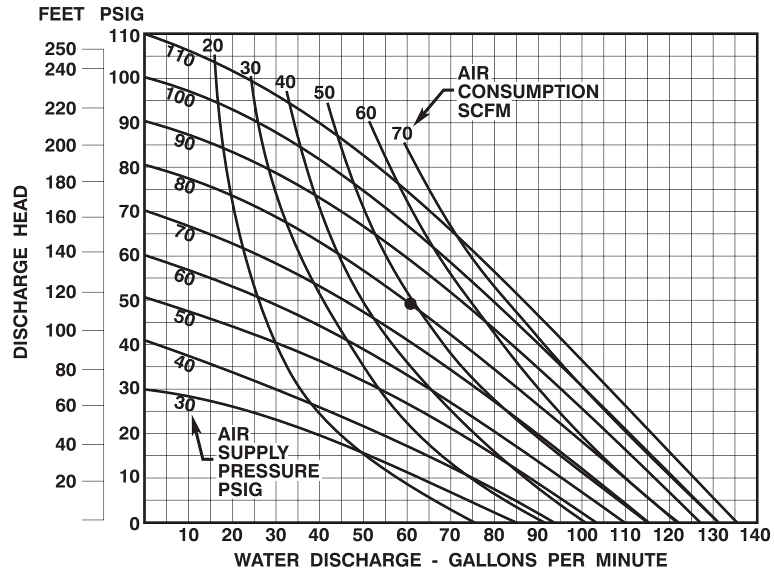
SUCTION LIFT DATA

SUCTION LIFT FEET	AIR SUPPLY PSI	DISCHARGE PRESSURE PSI	GPM LOSS
0	100	0	0
-5	100	0	-1
-10	100	0	-2
-15	100	0	-3
-20	100	0	-5
-25	100	0	-10

EXAMPLE: TO PUMP 10 GPM AGAINST A DISCHARGE PRESSURE OF 65 PSIG, REQUIRES 80 PSIG AND 10 SCFM AIR CONSUMPTION

SPECIAL NOTE: WHEN CALCULATING FLOW RATE, LOSS IN GPM FROM SUCTION LIFT MUST BE SUBTRACTED FROM PERFORMANCE SHOWN ON CURVES WHICH ARE BASED ON FLOODED SUCTION (ZERO SUCTION LIFT)

Figure 4-6. Performance and Specification, Pneumatic Double-diaphragm Pump with 1-Inch Outlet.



HEIGHT........ 26' 1/4"
WIDTH........ 16' 1/8"
DEPTH........ 13"
WEIGHT
(ALUMINUM) .... 72 LBS
(STAINLESS/HASTELLOY) .... 128 LBS
AIR INLET........ 1/2" NPT
INLET........ 2" MALE NPT
OUTLET........ 2" MALE NPT
SUCTION LIFT........ 20' DRY
25' WET
MAX. SIZE SOLIDS .... 1/4" DIA

EXAMPLE: TO PUMP 60 GPM AGAINST A DISCHARGE PRESSURE OF 50 PSIG, REQUIRES 50 PSIG AND 50 SCFM AIR CONSUMPTION

SUCTION LIFT DATA

SUCTION LIFT FEET	AIR SUPPLY PSI	DISCHARGE PRESSURE PSI	GPM LOSS
0	100	0	0
-5	100	0	-1
-10	100	0	-2
-15	100	0	-3
-20	100	0	-5
-25	100	0	-10

SPECIAL NOTE: WHEN CALCULATING FLOW RATE, LOSS IN GPM FROM SUCTION LIFT MUST BE SUBTRACTED FROM PERFORMANCE SHOWN ON CURVES WHICH ARE BASED ON FLOODED SUCTION (ZERO SUCTION LIFT)

Figure 4-7. Performance and Specification, Pneumatic Double-diaphragm Pump with 2-Inch Outlet.

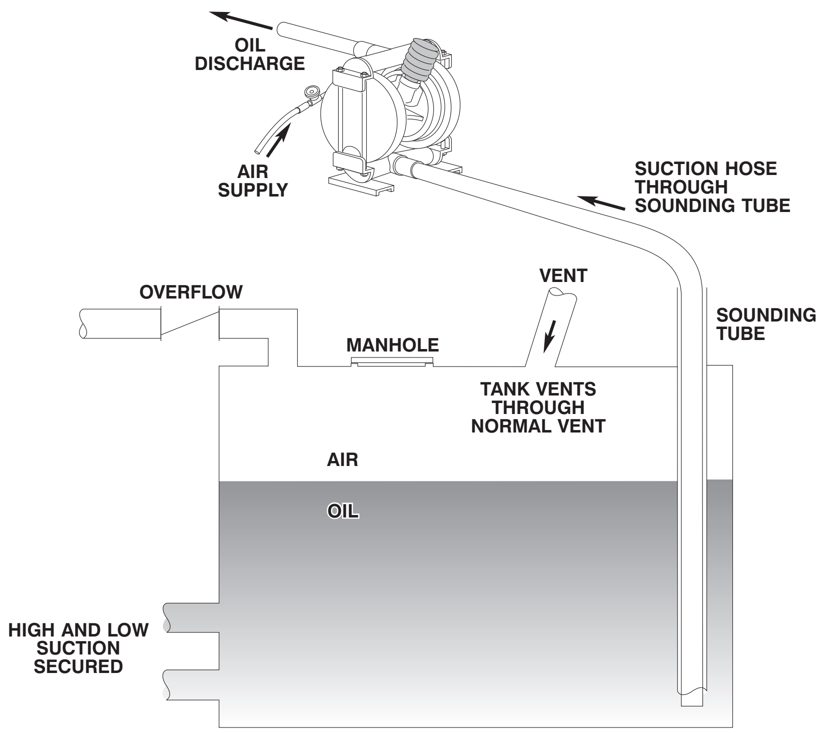


Figure 4-8A. Pneumatic Double-diaphragm Pump Rigged Through a Sounding Tube.

The pumps have the advantage of not requiring the tank to be opened. The suction hose may be rigged through a vent, sounding tube or keel plug as illustrated in Figures 4-8A through 4-8G. Like reciprocating pumps, the pneumatic double-diaphragm pump may be used as booster pumps in manifolded systems. Tanks can be vented to the atmosphere if above the waterline or submerged to shallow depths, but pressurized air may be required at deeper depths to prevent tank collapse.

Pneumatic double-diaphragm pumps are neither stocked in the ESSM System nor issued to Navy salvage ships and units. The pumps are widely available commercially as they find application in a number of industries.

Although the pump presents no explosion hazard itself, it does require an air compressor as a prime mover. The compressor must be in a fume-free area.

4-3.1.7 <u>Eductors</u>. Fuels are seldom pumped with eductors. To avoid contamination of the fuel being pumped, oil of the same type must be the driving fluid for the eductor. It is difficult to produce enough pressure pumping oil in a salvage operation to drive an eductor effectively. In addition, the difficulty of rigging the system is seldom, if ever, worth the effort. Eductors are suitable for removing badly contaminated fuels that are to be disposed of. In these cases, water from any suitable pump may drive the eductor. JP-5 and other fuels that are static accumulators should not be pumped with water-driven eductors.

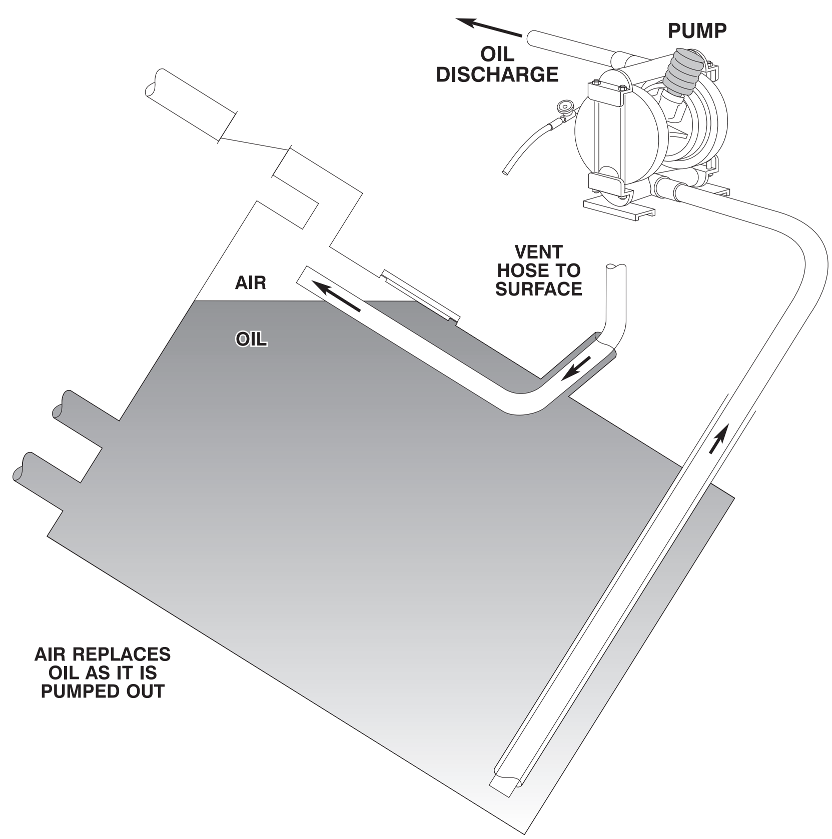


Figure 4-8B. Pumping and Natural Venting, Tank Inclined Less Than 90°.

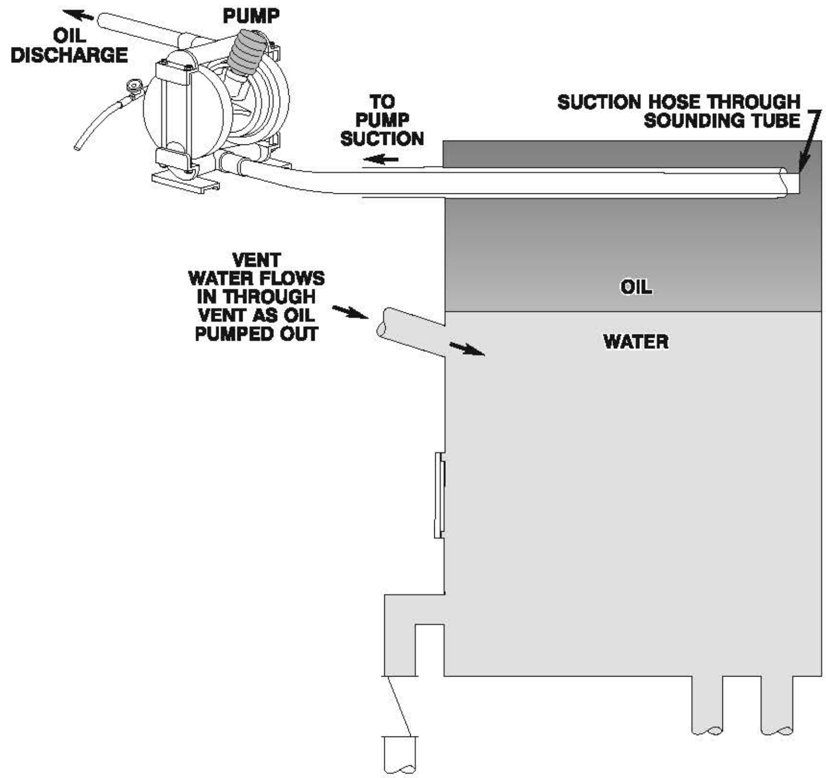


Figure 4-8C. Pumping and Natural Water Replacement, Tank Inclined at 90°.

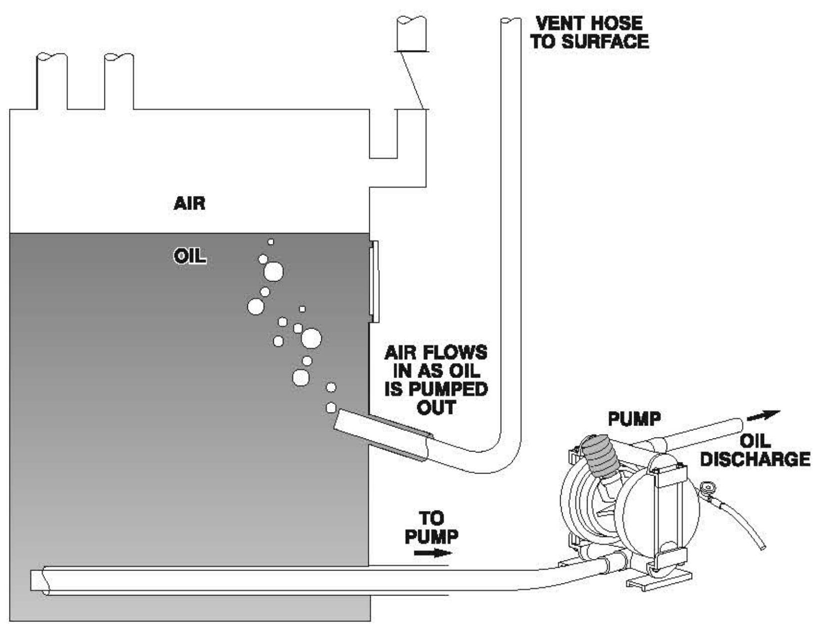


Figure 4-8D. Pumping and Natural Venting, Tank Inclined at 90°.

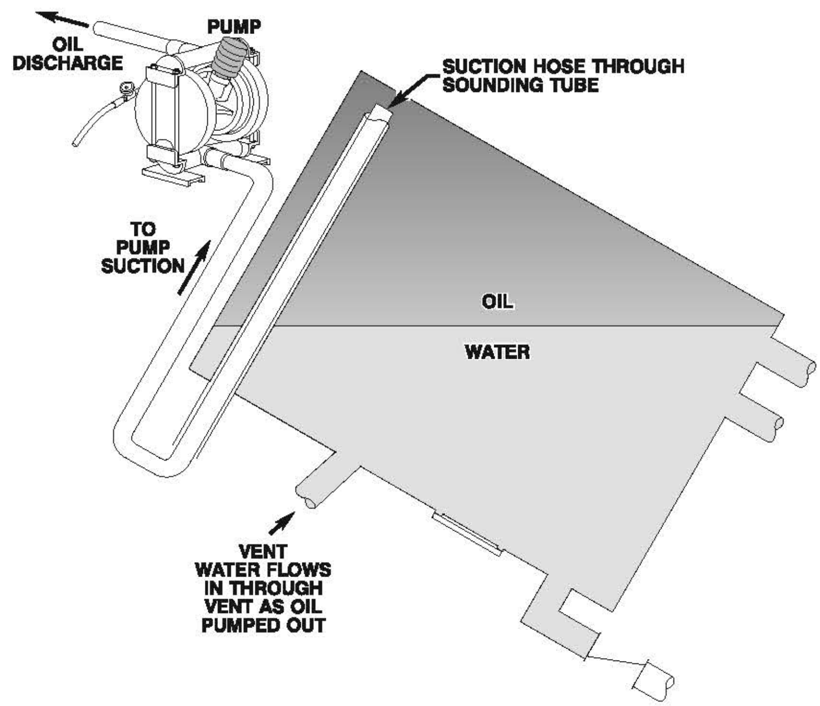


Figure 4-8E. Pumping and Natural Water Replacement, Tank Inclined More Than 90°.

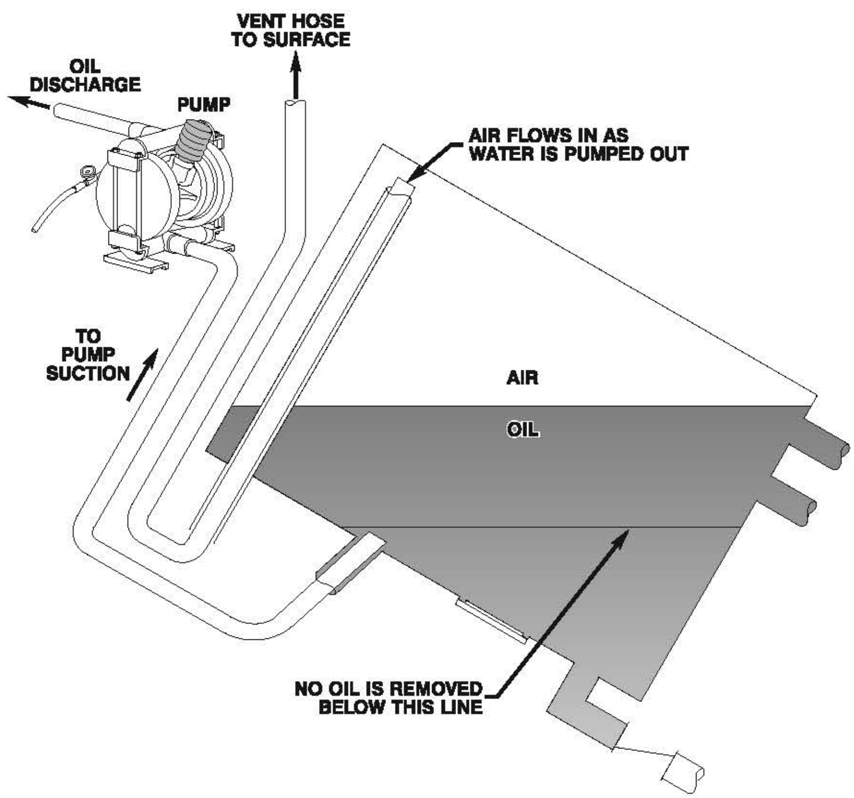


Figure 4-8F. Pumping and Natural Venting, Tank Inclined More Than 90°.

4-3.2 Water Displacement. Water or hydraulic displacement consists of pumping water into the tank, preferably low in the tank, to force the lighter oil higher and out through the vent or a fitting installed to pass the oil. Water displacement is a simple and safe way to remove flammable liquids. It is the safest way to handle gasoline and other Flammability Grade A liquid.

If the tank is upright or positioned so the vent is at the highest point of the tank, fumes in a partially filled tank are forced out, then the tank is filled with liquid so there is no space for explosive fumes to collect.

The following steps are necessary to remove fuel from an upright, intact tank by water displacement:

a. One fitting into the top of the tank—the manhole, vent, or overflow—is chosen and fitted with a connection for handling fuel displaced from the tank.

b. Fittings through which fuel can escape are blanked or sealed and valves gagged.

c. A hose is inserted through the sounding tube near the bottom of the tank.

d. Water is introduced into the tank until oil begins to flow from the hose.

Figures 4-9A through 4-9D illustrate water displacement of oil from inclined tanks.

WARNING

Pressurizing fuel tanks with compressed air can increase the oxygen partial pressure enough to bring the fuel vapor-air mixture into the flammable range.

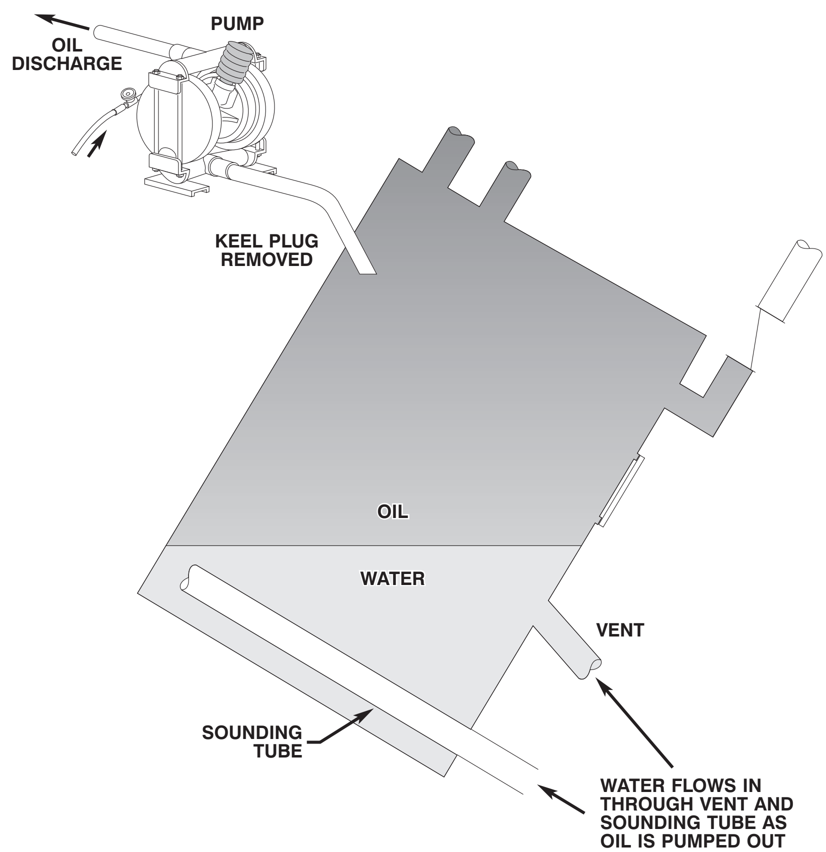


Figure 4-8G. Pumping Through Removed Keel Plug.

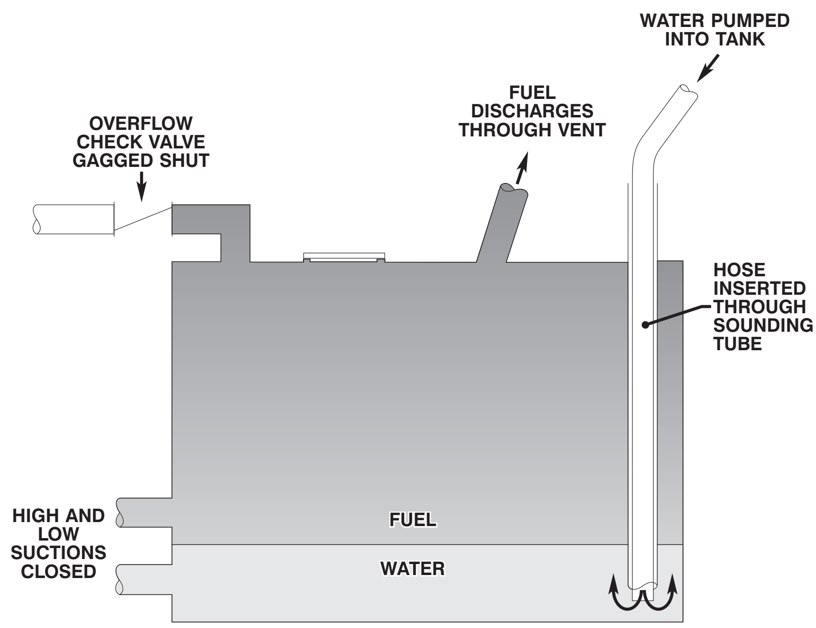


Figure 4-9A. Water Displacement of Fuel From an Upright Intact Tank.

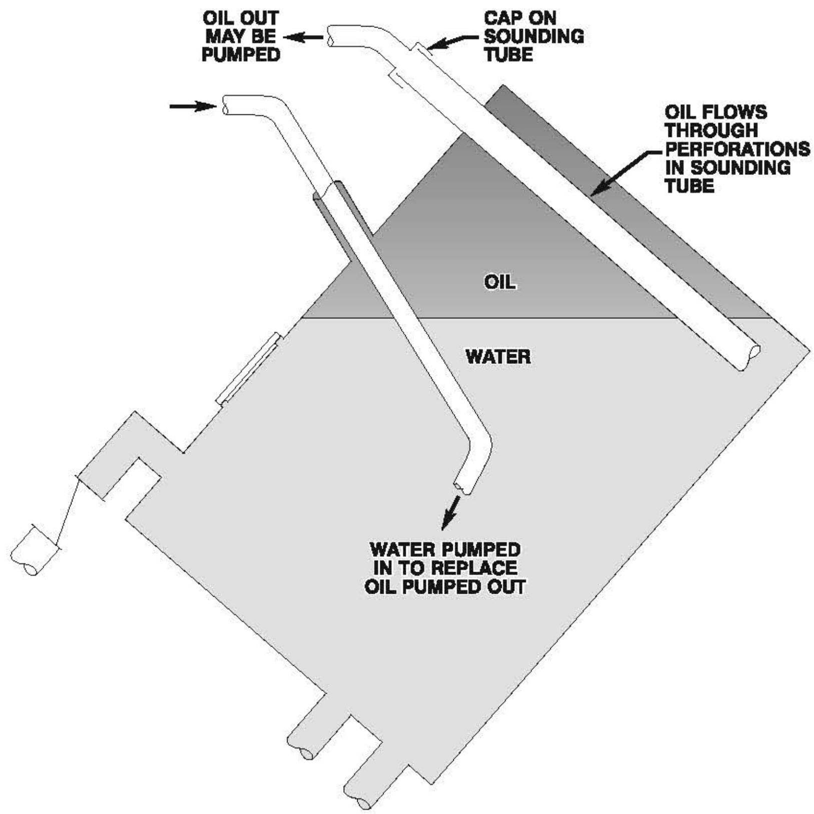


Figure 4-9B. Water Displacement, Tank Inclined Less Than 90°.

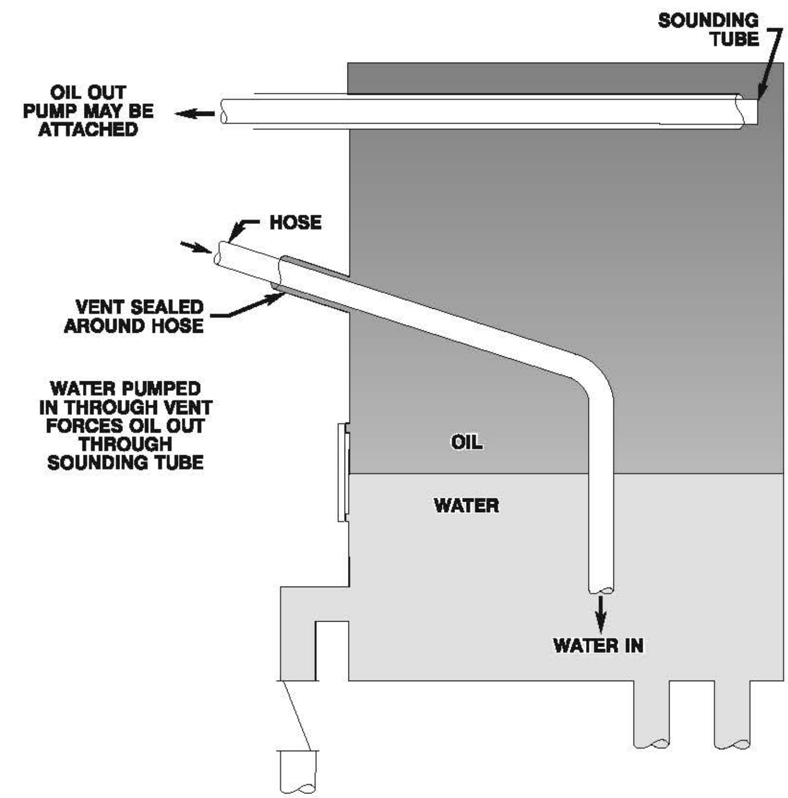


Figure 4-9C. Water Displacement, Tank Inclined at 90°.

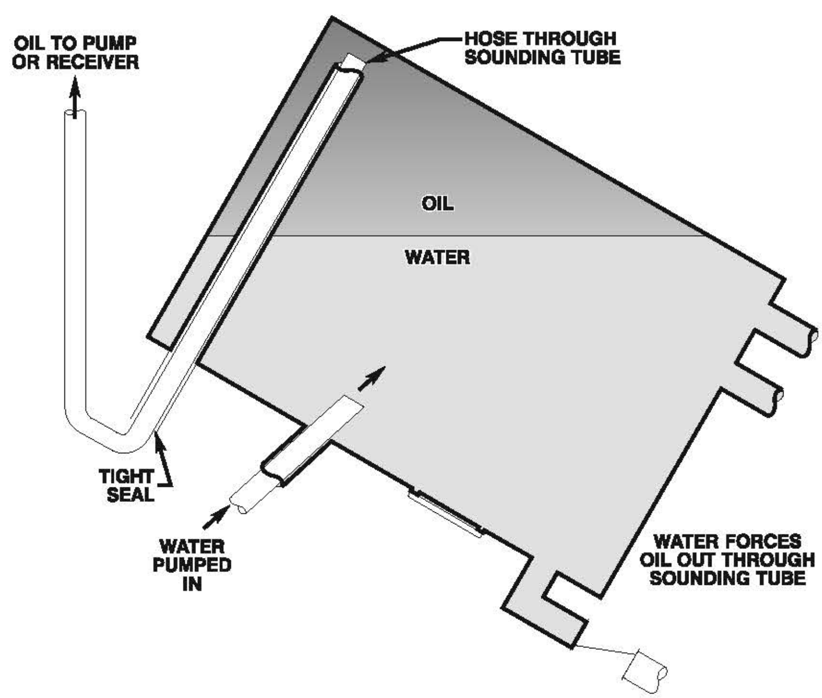


Figure 4-9D. Water Displacement, Tank Inclined at More Than 90°.

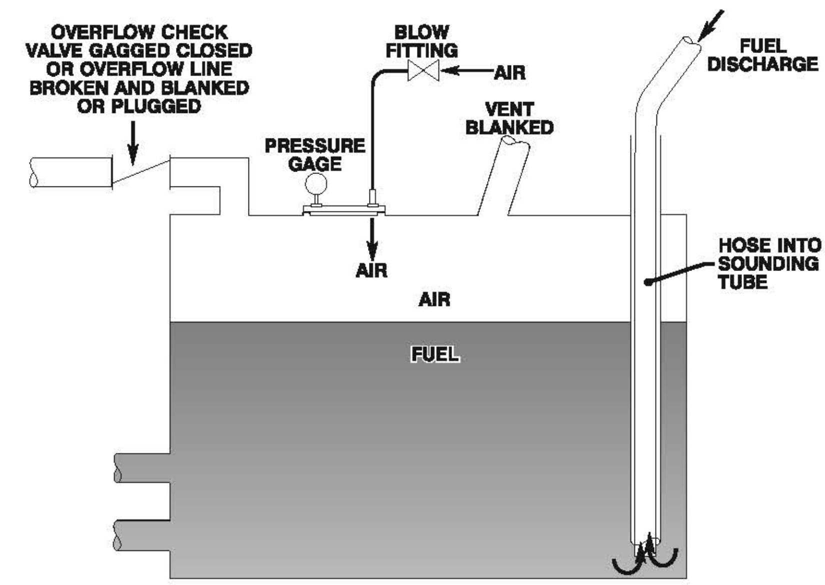


Figure 4-10A. An Intact Tank Rigged for Blowing with Air.

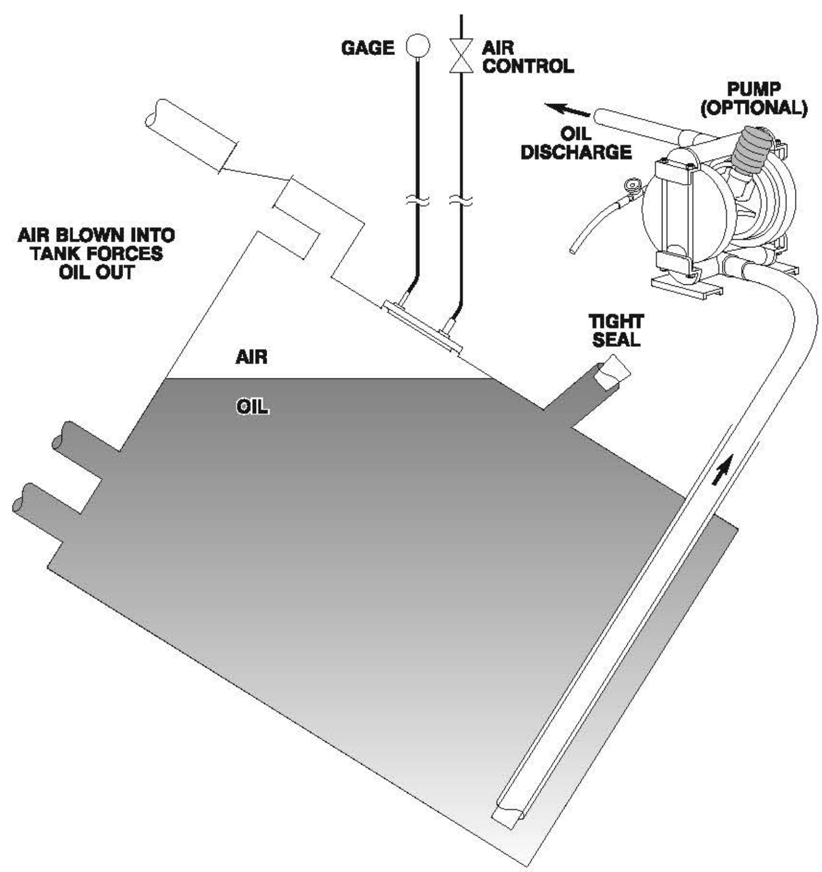


Figure 4-10B. Blowing with Air, Tank Inclined Less Than 90°.

4-3.3 Air. Fuels can be blown from tanks by compressed air. In tanks that are intact and relatively upright, air introduced into a sealed tank will force fuel out of the tank through an outlet near the bottom. Introducing air under pressure into a tank containing oil is relatively dangerous because the space above the oil contains a potentially explosive vapor, and an increase in absolute pressure is necessary to blow out the fuel — whenever compressed air is blown into a tank containing fuel vapors there is the potential for explosion.

The following steps are necessary to blow fuel from an upright, intact tank:

a. One fitting into the top of the tank—the manhole, vent, or overflow—is chosen and fitted with an air connection and pressure gauge.

b. Fittings through which air can escape are blanked or sealed and valves gagged.

c. A hose is inserted through the sounding tube to near the bottom of the tank.

d. Air is introduced into the tank slowly until the predetermined pressure is reached and oil begins to flow from the hose.

e. Blowing is continued at a rate that just maintains the minimum pressure necessary to move fuel out of the tank.

Figure 4-10A shows an upright intact tank rigged for blowing with air. If the tank is not upright, the location of the fitting must be taken into account and the tank rigged with a system that is workable. Figure 4-10B illustrates the rigging of air into a tank in a capsized ship with the sounding tube on the upper side. Figures 4-10C and 4-10D illustrate methods of rigging air into inclined tanks.

WARNING

Pressurizing fuel tanks with compressed air can increase the oxygen partial pressure enough to bring the fuel vapor-air mixture into the flammable range.

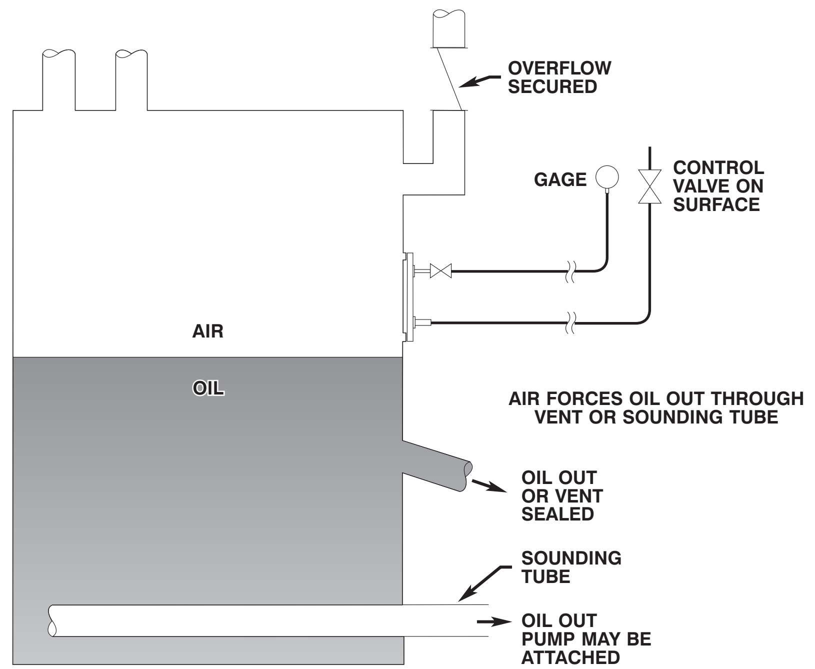


Figure 4-10C. Blowing with Air, Tank Inclined at 90°.

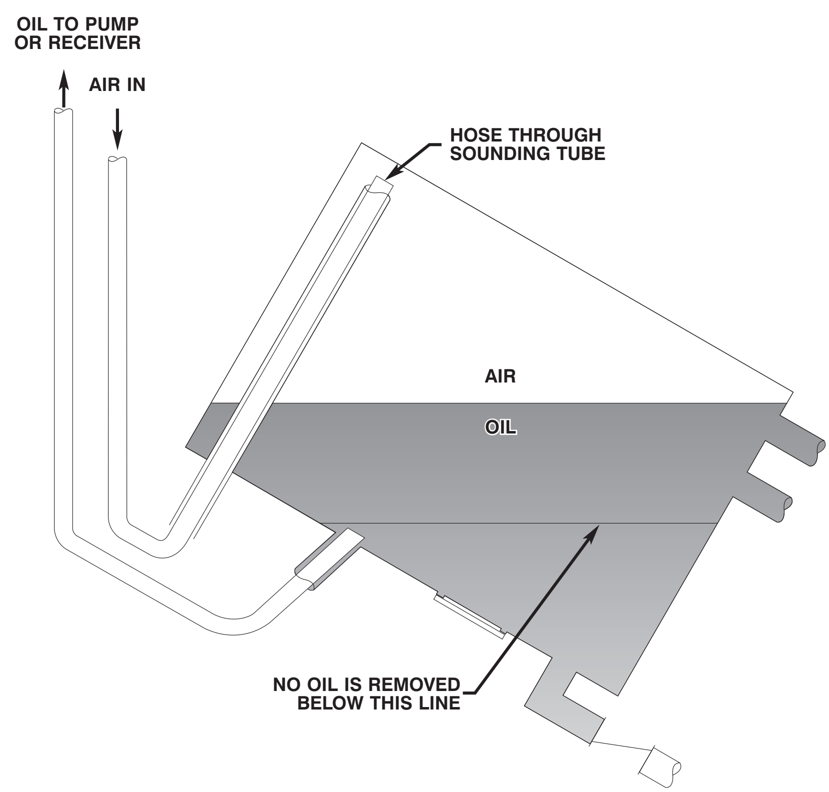


Figure 4-10D. Blowing with Air, Tank Inclined More Than 90°.

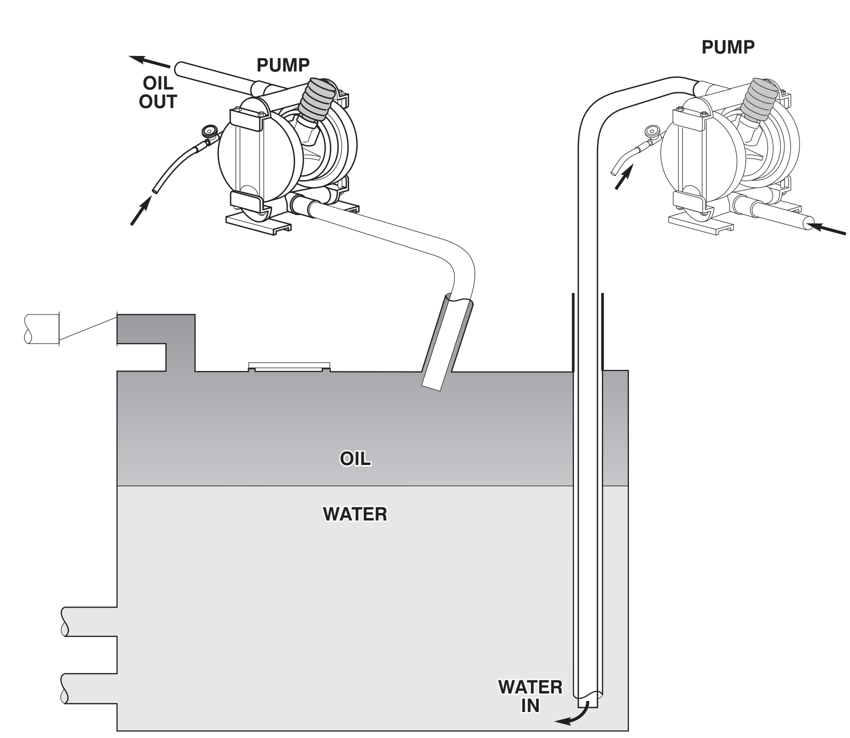


Figure 4-11A. Combined Water Displacement and Pumping.

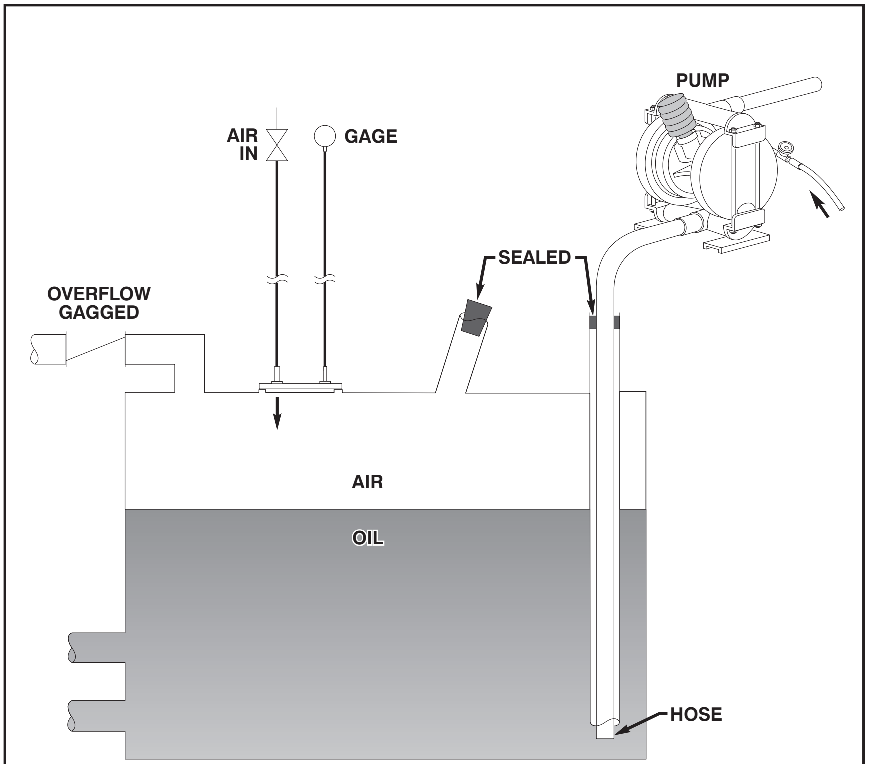


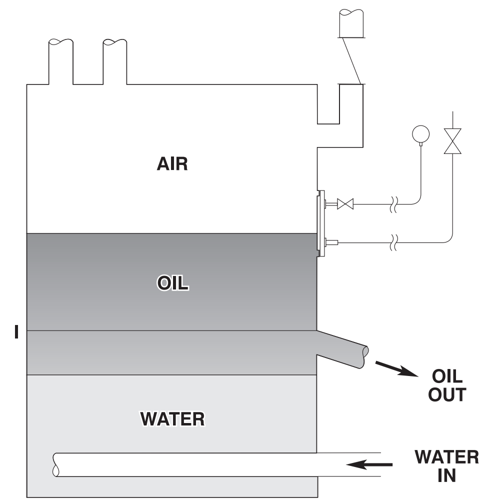
Figure 4-11B. Combined Air Blowing and Pumping.

4-3.4 Combinations. Pumping may be used in conjunction with both water displacement and blowing with air by rigging a pump to the fuel discharge from the tank. Positive displacement pumps—reciprocating or pneumatic double-diaphragm—are best. Figures 4-11A and 4-11B illustrate pumps rigged with water displacement and air blowing systems. Pumping combined with blowing works very well, but the tank should always be fitted with a pressure gauge to permit control of the pressure and avoid overpressurizing. When pumping is combined with water displacement, the pumping rates must be balanced to prevent either overpressurizing the tank or drawing a vacuum and causing it to implode.

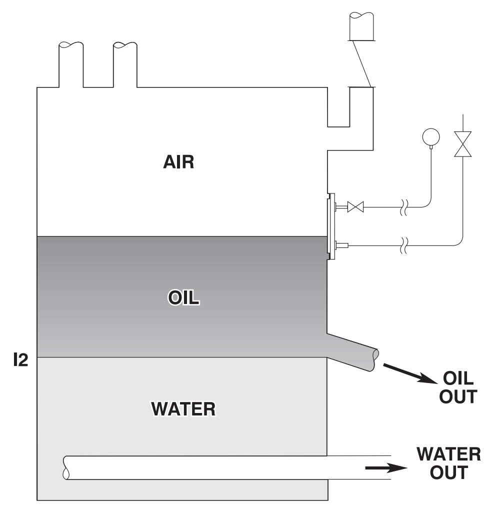
In partially filled inclined tanks, air may be forced into the unvented high part of the tank and compressed there. In these cases, flow from the tank vent should be monitored constantly. When the fume flow ceases, the water injection rate should be reduced so that water flows in only as fast as the flammable liquid flows out. A slow water injection rate ensures that POL flows from the tank while the layer depth decreases and the fumes are not compressed. Ideally, depth in the tank is constant. If water is pumped into the tank more rapidly than oil flows out, pumping may be stopped until the compressed atmosphere in the tank blows the liquid level down to equilibrium and flow stops. If the oil-water interface passes the removal fitting, it may be necessary to blow air slowly into the tank. Upon completion of removal of the flammable liquid, the tank may still contain a potentially explosive atmosphere above the water.

It is unwise to abandon or attempt to clear the wreck while pockets of explosive gas exist. Air may be blown slowly into the tank until the atmosphere is blown out of the removal fitting. The tank should be purged until monitoring shows the vented gases are well below the explosive range. The area in which the vented gases bubble to the surface should be treated as extremely hazardous. Figure 4-12 illustrates removal of oil from a tank inclined at 90 degrees by a combination of water displacement and blowing.

4-3.5 Commercially Available Vacuum Units. When the casualty is alongside a pier or a barge can be brought alongside, vacuum trucks (Figure 4-13) and skid-mounted vacuum units (Figure 4-14) can be utilized to remove oil. These commercial units are available in most ports. Generally, the tank trucks have a limited storage capacity and a vacuum capable of drawing 25 inches of suction. Both types of units may come with all ancillary equipment needed to operate at any site, but it is recommended that the contractor be provided with specific information on how the unit will be used so they can be sure to bring the correct equipment to meet the needs of the lightering operation.



1. WATER IS PUMPED IN UNTIL OIL-WATER INTERFACE REACHES I AND WATER FLOWS OUT OF VENT



2. AIR IS BLOWN IN UNTIL AIR-OIL INTERFACE REACHES I2 AND AIR FLOWS OUT OF VENT

Figure 4-12. Iterative Water Displacement and Blowing.

Figure 4-13. Skid-Mounted Vacuum Unit.

Figure 4-14. Vacuum Truck.

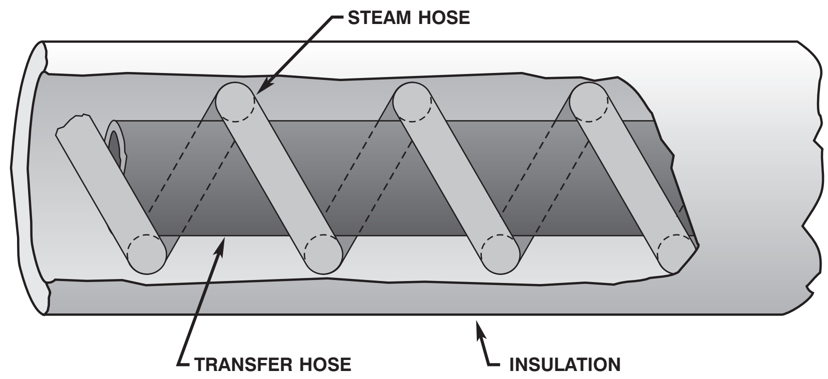


Figure 4-15. Transfer Hose with External Steam Hose.

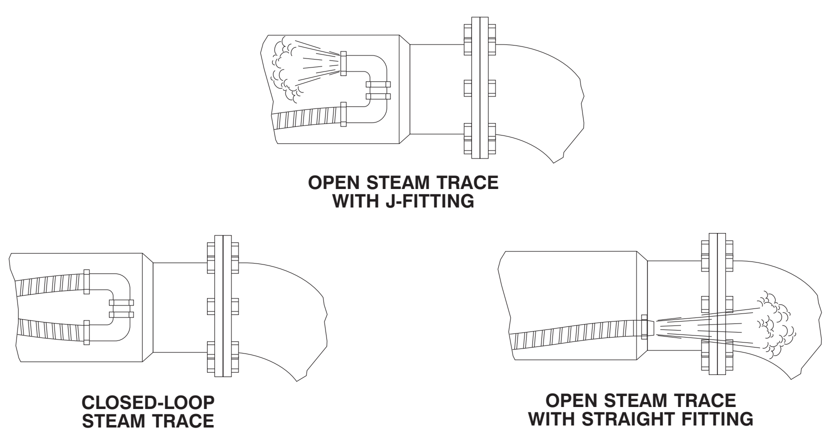


Figure 4-16. Steam Traces.

There is no equipment designed specifically for heating oil in salvage; equipment must be improvised. If the casualty has tank-heating coils, they are the first choice for heating the oil. Heat for installed systems may be supplied from the casualty, a salvage ship, or a portable source. The most common heat source is steam supplied to tank heating coils, hoses that trace the steam lines, or hoses or coils placed in the tank. Steam may be provided from any source. The portable steam generator stocked in the ESSM system and described in Appendix C provides a maximum of 3,300 pounds/hour of saturated steam at 200 psi and 382 degrees Fahrenheit. The generator is shipped with a heating coil that may be put into a tank through a manhole or hatch or may heat a secondary fluid that heats the oil in the tank. The steam generator is a potential ignition source and should be placed in a well-ventilated location that is free of fumes.

When submersible pumps are placed into fuel tanks through manholes, loops of steam hose in the oil near the pump can raise the temperature of the oil enough to increase pumping efficiency. In these cases, the hose in the oil should be convoluted metal hose to improve the heat transfer efficiency. Loops of steam hose or open-ended steam hose may be put into tanks through any piping or fitting large enough to accommodate them.

Hose traces may be either external or internal to the transfer hose. As illustrated in Figure 4-15, hoses external to the transfer hose should be wrapped spirally around the transfer hose and covered with any available insulating material to reduce heat loss to the atmosphere. External steam traces are suitable for relatively small diameter hose that is too small for internal traces.

4-4 OPERATIONAL NOTES.

The collection of miscellaneous notes in this paragraph have proven their practical value in numerous emergency transfer operations.

4-4.1 Trapped Oil. Tank geometry and the physics of suction will prevent removing 100 percent of the oil in any tank by practical means. The obligation of the salvor is to remove as much oil as is safe and practical by judicious selection and application of removal methods and to be able to demonstrate to the proper authorities that he has done so. Upon completion of the oil removal operation, the quantity of trapped oil should be the practical minimum. *Volume 1* discusses techniques for skimming oil from water in large tanks.

4-4.2 Cold Weather. Most oils are pumpable at temperatures at which salvors can work. In cold temperatures, heavy residual oils, including Bunker C, may become so viscous that they cannot be pumped without raising their temperature. Usually, an increase of a few degrees in a limited volume of oil is enough to lower the viscosity enough to make a significant difference. It is not necessary to heat an entire tank. Should it become necessary to stop pumping for any reason, very viscous oil may clog the transfer hose and prevent further transfer until the viscosity is reduced. Heating of the transfer hose can eliminate this problem.

Six-inch diameter or larger transfer hose may be traced internally by 1½-inch diameter convoluted metal steam hose. Internal traces should not run through gate valves that isolate oil tanks. If the transfer hose ruptures, the steam hose cannot be withdrawn quickly enough to prevent a serious spill by closing the valve and isolating the tank.

Figure 4-16 shows three ways of configuring internal steam traces. The closed trace recirculates the condensate to the boiler. Open traces exhaust the steam into the oil near the end of the transfer, thereby theoretically giving additional heating by direct contact. The closed trace conserves boiler feed water and should be used where this quantity is in short supply. Open traces exploit the affinity of some heavy fuel oils for water. These oils form emulsions easily; if emulsions are formed, the viscosity of the oils is reduced quickly. Since oil, when mixed with water, is considered contaminated, deliberate introduction of condensate into the oil is appropriate when oil is being removed to prevent pollution and there is no intention of salvaging the oil (or the oil will transferred into settling tanks and be purified at a later time).

Steam may also be injected directly into the suction area through a fitting in the transfer piping or the deck. These arrangements, shown in Figure 4-17, have the advantage of heating the oil in the tank immediately before it enters the hose. Direct injection of steam should be combined with steam tracing of the hose, particularly if the hose runs a considerable distance through cold water.

WARNING

Heating devices used in and around fuel tanks and transfer hoses must be intrinsically safe to avoid explosion.

Electrical strip heaters or blankets may be placed around transfer hoses and covered with insulating materials. Immersion heaters may be placed in the tanks themselves. All electrical equipment should be maintained intrinsically safe or isolated from any contact with oils, their fumes, and explosive vapors.

4-4.3 Destinations for Removed Oil. Before beginning a transfer operation, salvors must have sufficient tankage available, and correctly and securely placed to receive the oil that is to be removed. The normal options include:

- Ships or barges alongside.
- Ships or barges in a standoff moor.
- Over-the-beach transfers.

4-4.3.1 Ships Alongside. The simplest transfers are to a lightering vessel alongside the casualty because rigging, transfer distances, and the number of vessels involved is minimal. This method should be chosen whenever the salvage ship has enough tankage to accommodate the oil removed from the casualty, and when it is possible to come alongside the casualty. When there is not sufficient tankage in the salvage ship, a barge may be moored alongside to receive the oil.

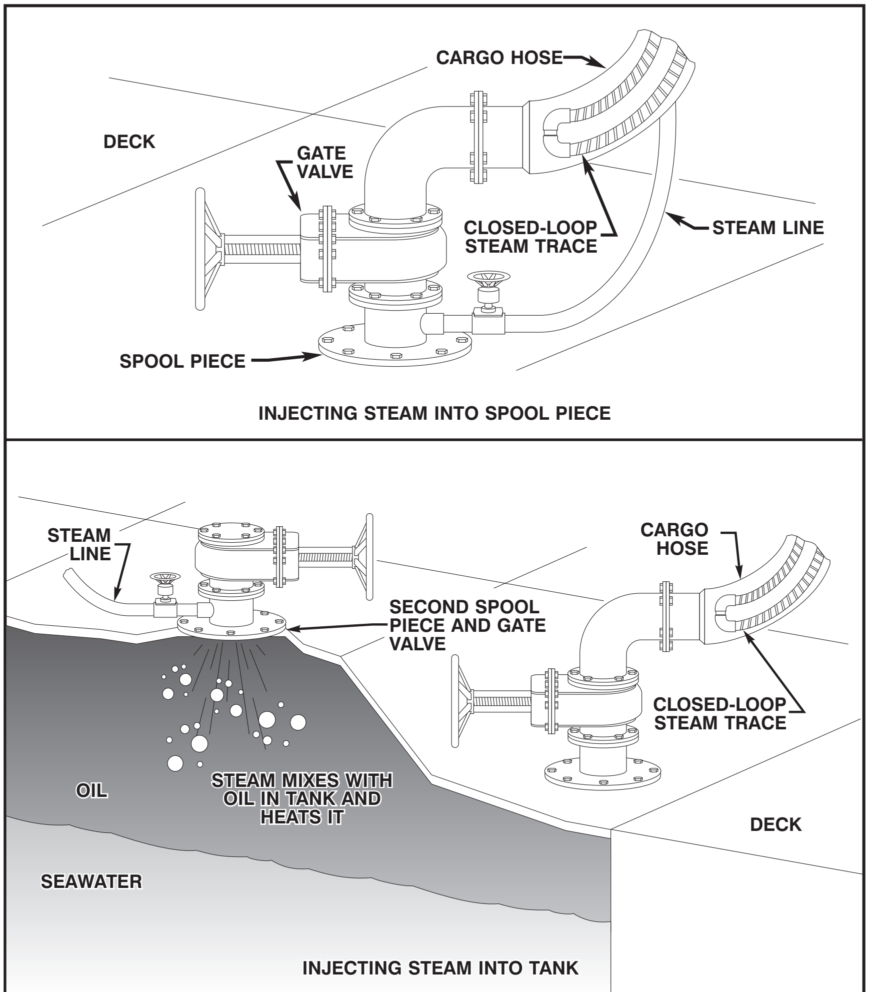


Figure 4-17. Steam Injection.

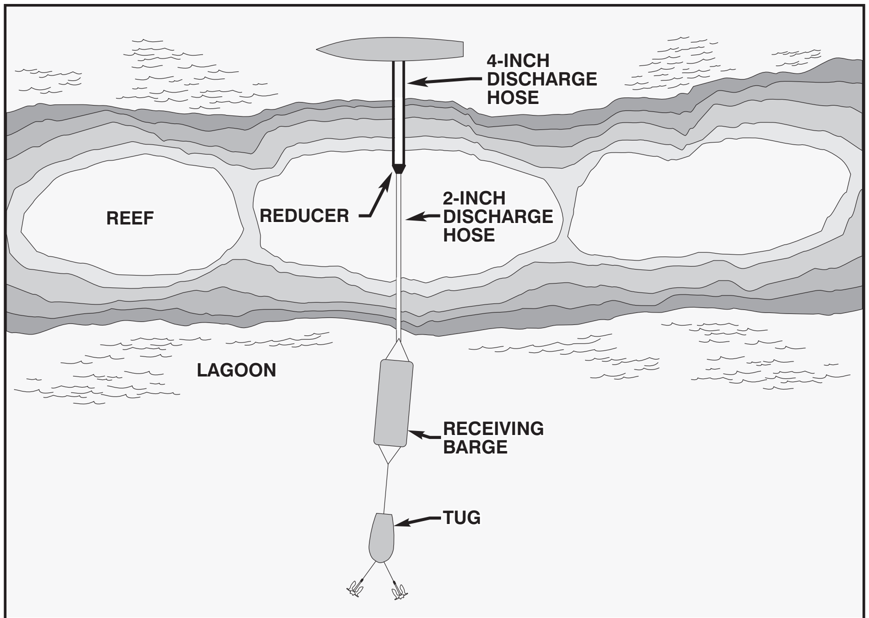


Figure 4-18. Receiving Barge in Standoff Moor.

Figure 4-19. M/V NEW CARISSA.

4-4.3.2 Standoff Moors. When the vessels cannot be brought alongside the casualty, they may be placed in a standoff moor such as that illustrated in Figure 4-18, and the oil removed through a floating hose string. The receiving vessel should be moored as closely as possible to the casualty to reduce the length of the hose string and the stresses on the hose working in the surf.

4-4.3.3 Over-the-Beach. Oil may be removed to tankage ashore rather than to seaward. In a relatively benign environment, floating hoses may be run through the surf and across the beach. In most cases, it is preferable to rig a highline to support the hose and keep it clear of the surf and the stresses that the surf imposes.

4-5 IN-PLACE DESTRUCTION OF PETROLEUM PRODUCTS.

In some environments, particularly in remote areas and in extremely high and low latitudes, burning to destroy the oil may be the preferred method of oil removal. Burning is most appropriate when the casualty is to be abandoned, the oil is contained within the casualty, and position of the casualty or the environment makes removal impractical.

These tenets could not have been truer in the grounding of the M/V NEW CARISSA, a 639-foot bulk freight ship that went aground three miles north of Coos Bay, Oregon. Responders and salvors, after an unsuccessful refloating operation, determined that they had two alternatives: try to pull the ship closer to shore to facilitate lightering or to pull the ship out to sea and attempt to burn the product onboard. With deteriorating weather conditions forecasted, it was determined that by pulling the vessel closer to shore would cause hull failure and release over 400,000 gallons of fuel oil that the vessel was carrying. The decision to conduct an *in-situ* burn of the remaining oil product and sink the ship was the only viable option for removing the threat (reference FOSC report and assessment in case study volume).

Figure 4-20. M/V NEW CARISSA.

For effective burning, the fuel must be contained within the ship or pumped off the ship to a containment and disposal site. The former is the most practical. The oil must have access to large volumes of combustion-supporting air; thus, the burning site must be relatively open with a large surface area and good ventilation. Flamer-burners that atomize oil for burning have been developed for salvage, but have not proven practical in the field. Burning the oil in bulk inside the ship has proven to be a satisfactory means of disposal. When fuel or cargo oil is burned for disposal, the contents of the ship burn with it. A survey should be made of the materials in the ship to determine if toxic or hazardous combustion products will be produced. An assessment of the environmental effects of combustion products should be made as part of the disposal method decision. Approval of local authorities is required in all cases except in military emergencies.

Simply opening the tank access manholes seldom provides an adequate entry for effective burning. Fill and transfer systems can be broken and fuel dumped or pumped into machinery spaces or holds and burned there. Tanks can be opened by explosive charges to increase the surface area of the oil available for combustion and allow large volumes of combustion-supporting air to reach the fuel. The tops of double-bottom tanks may be cut open. Deep tanks can be split vertically so that their contents dump into holds or machinery spaces.

When double-bottom tanks are filled or holed so that the residual oil is pressed up to the tank top, all spaces between longitudinals and floors must be opened to ensure all the oil burns. If holds contain cargo that is to be abandoned, it may be necessary to remove all or a portion of the cargo to reach the inner bottom and open the tanks. Fuel in double-bottom tanks under flooded spaces floats to the surface when the tanks are opened.

When tanks are opened explosively, there is a possibility that the explosion will ignite the fuel. Intentional explosive ignition of fuel concurrent with opening the tanks is entirely practical and is done in some cases. Whenever oil is ignited explosively, it should be part of a planned process. To avoid accidental premature ignition, the tanks should be opened manually. Tanks opened manually should be pressed up with water so there is no space for explosive fumes to collect in the upper part of the tank. Even with pressing up, fumes may collect in high portions of the tanks if the ship is in a position that permits the formation of pockets away from vents. Mechanical openings should be made low in the tanks where fumes are least likely to pocket. To further reduce the danger of explosion, the space above the tanks may be flooded to a depth of a few inches and the tank opened by chipping, drilling, or sawing. If drilling confirms the absence of fumes, the tank may be opened by exothermic cutting.

Light fuels and lubricating oils may be ignited directly by time-fused or remotely fired explosive charges or, preferably, thermite devices. Heavy fuels are difficult to ignite in cold climates or when floating on cold water. Diesel fuel or gasoline spread on the surface of the water and ignited with a time fuse or remotely fired explosive or thermite device will raise the temperature of the heavy oil enough for ignition. An explosive or thermite device strapped to a drum of gasoline, diesel oil, or other light fuel is a very effective ignition device.

Explosive opening of tanks, followed closely by a second series of explosions to ignite the oil as it flows from the open tanks, has been successful in a number of cases.

CHAPTER 5
PETROLEUM CARGOES EMERGENCY TRANSFER OPERATIONS

5-1 INTRODUCTION.

Transfer operations may be divided into three categories by the method of moving the cargo:

- Transfers with installed equipment.
- Over-the-top transfers.
- Combined transfers.

In transfers with installed equipment, cargo is transferred by the casualty's pumps through her piping systems. These transfers most nearly approximate a normal cargo offloading operation. For over-the-top transfers, portable hydraulic pumps are placed in the cargo tanks and pumping is through portable hoses. In combined operations, portable pumps transfer cargo over-the-top from damaged tanks to sound tanks. The cargo is in turn pumped from the sound tanks to the receiving vessel with the casualty's installed equipment.

5-2 TRANSFER OPERATIONS.

No matter how the cargo is moved, there are general principles and considerations that apply to all cargo transfer operations. All ship-to-ship operations are in fact two separate, simultaneous, mutually dependent operations: an offloading operation by one ship and a loading operation by the other. Often the capabilities of the ships are very different. The entire operation must match the least capable ship. The receiving vessel's crew must not allow the relatively routine nature of the loading operation to detract from a high level of care and vigilance.

All U.S. Navy ships have Engineering Operation Sequence System (EOSS) manuals that establish detailed guidelines and procedures for normal POL transfer operations. The U.S. Coast Guard requires commercial tankers trading in U.S. ports to have a Cargo Transfer Procedures Book that can usually be found in the Cargo Office. The guidelines and procedures found in these manuals have been validated in operations. They should be followed explicitly by the salvage crew unless the salvage officer orders deviation from them. Existing pretransfer, transfer and posttransfer checklists should be completed.

All emergency POL cargo transfer operations carry a high degree of risk. Mistakes are very costly. The operations should proceed with deliberation, one step at a time. Each step should be completed satisfactorily before going ahead to the next step. Actual transfers should begin very slowly with very low pumping rates and work up gradually as the systems check out. Whenever there is an abnormality or malfunction, pumping must be secured until it is corrected and resumed with the same step-by-step deliberation.

Because tank suctions are located in the after part of the tank, the casualty should be trimmed by the stern during transfers. In general, tanks should be pumped from forward to aft unless operational requirements dictate differently.

The sequence for tank offloading is based on the structural impact of the weight change and the potential loss of POL from damaged tanks. Multi-product transfers are very likely to require a specific discharge sequence that maintains acceptable stress levels while still preserving each product's integrity.

Pumping damaged tanks first minimizes pollution as well as saves cargo. Oil in damaged tanks floats on top of and is replaced by floodwater as it is removed, resulting in little change in hull stresses and ground reaction. Crude oil and some refined products break down in contact with seawater. Accordingly, it is desirable to remove cargo quickly from as many damaged tanks as possible to prevent loss of the cargo. Removal of cargo from intact tanks in stranded ships commonly requires ballasting to maintain the ground reaction and prevent premature refloating. The importance of maintaining ground reaction in stranded ships is discussed in Chapter 6, *U.S. Navy Ship Salvage Manual, Volume 1,* S0300-A6-MAN-010.

5-2.1 Stress Monitoring. Both loading and offloading tankers causes large changes in load that result in changes of hull stresses. Hull stresses, effects of load changes, and methods of calculations are discussed in Chapter 5, *U.S. Navy Ship Salvage Manual, Volume 1),* S0300-A6-MAN-010. Loading, offloading, ballasting, and deballasting sequences must be planned carefully to prevent excessive hull stresses and the possibility of catastrophic hull failure. Most modern tankers are fitted with load computers that permit the determination of stress levels for various tank loadings. These computers are valuable in determining stress levels and working out sequencing for intact, floating ships. Most load computers are programmed for intact, floating conditions and should not be relied on when the ship is aground or has hull damage and a loss of section modulus. Some are programmed to deal with flooding resulting from hull damage and with stranded conditions, but few, if any, can account for loss of section modulus.

When the ship is aground or damaged, the stress levels in the hull and offloading sequences should be worked out with the assistance of a salvage engineer.

Often there will be pressure from an interested party to fit strain gauges on the tanker hull. Strain gauges will give an indication of changes in strain and rate of change of strain from an indeterminate condition. Changes in stress and rates of change of stress can be determined from changes in strain if the hull is intact. If the section modulus of the hull has been reduced by undefined damage, only estimates of changes of stress can be made. Changes in hull deflection, as indicated by a variation from a level line, are an excellent indicator of general changes in hull stresses. Determination of deflection with a level line is described in Paragraph 6-7 of the *U.S. Navy Ship Salvage Manual, Volume 1,* S0300-A6-MAN-010.

Despite the difficulties of obtaining accurate estimates of hull stress levels, every attempt should be made to acquire the most accurate information possible and to develop tank, load and ballast sequence plans based on sound information.

5-2.2 Transfer Hoses. Cargo moves between vessels through hose strings tailored to the particular circumstances of the operation. Hose strings must be long enough to accommodate the changes that will occur during the transfer and must be of a diameter compatible with both vessels. A common arrangement is to use two strings of 4- to 12-inch hose, long enough to handle all vertical and horizontal movement between the vessels without adding or removing sections during the operation.

Hoses and associated hardware compatible with the installed system and cargo are usually found aboard the casualty. If this equipment is not acceptable, hose and fittings may be brought to the scene in the receiving ship or a support vessel.

If either the casualty or receiving vessel is a Navy oiler with refueling at sea (RAS) equipment and multiple pump rooms in operating order, there may be several variations for rigging transfer hoses. RAS hoses are collapsible and lightweight and come in 35-foot sections of 5-inch, 6-inch, and 7-inch diameters. They have three types of terminal fittings, all designed for quick release:

- The breakable spool (NATO).
- The combined quick release (Robb) coupling and valve.
- The fueling probe.

Any naval vessel capable of being refueled at sea is compatible with this equipment.

Commercial hose is available in three types:

- R – rough bore hose; heavy, robust hose with an internal steel wire helix.
- S – smooth bore hose; lighter than rough bore hose without the steel wire helix.
- L – lightweight hose, normally suitable for discharge and fueling only, but especially suitable for emergency transfers and salvage where flexibility and light weight may be important.

All three types are available as floating hoses. Floating hose is designed with sufficient buoyancy to keep the hose afloat when it is filled with seawater. Alternatively, hoses can be supported by flotation cells. Flotation cells must have enough buoyancy to support the hose when it is filled with oil.

Hose should comply with API, ASA, British Standard, Japanese Industrial Standard, OCIMF, or MILSPEC specifications. The hose should be marked with:

- The manufacturer's name and serial number.
- Specification or standard of manufacture.
- Month and year of manufacture.
- Factory test pressure.
- Date of most recent pressure test.
- Whether electrically continuous or discontinuous.

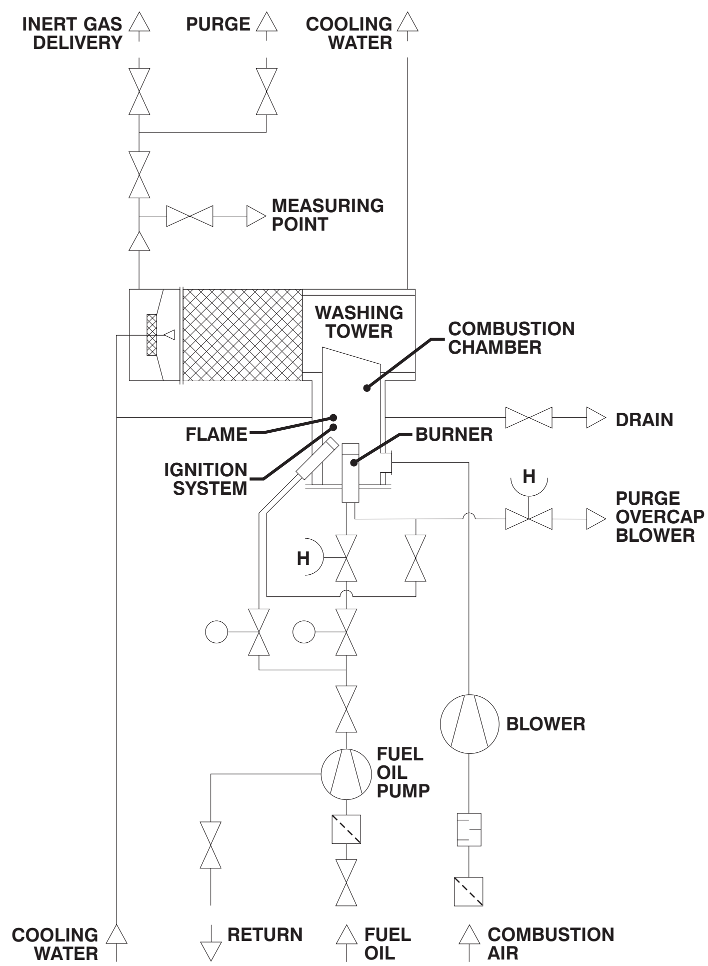


Figure 5-1. Inert Gas Generator Schematic.

The rated test pressure, maximum flow rate, and oil temperatures of 180 degrees Fahrenheit should not be exceeded. The most recent pressure test should be within one year of the date of intended use. Before it is connected, the hose string should be inspected for defects in the bore or outer covering. Defects that disqualify the hose for service are: blister areas larger than the base of a cup, kinking, cracking deeper than about $^3/_{64}$-inch (one millimeter), severe abrasion, flattening, evidence of leaks, and badly corroded flanges.

Most vessels will have hose booms, cranes, or other devices located near their POL handling connections for hose handling while making the connection between ships. Properly radiused saddles are necessary to support and suspend the transfer hose. As a rule of thumb, the minimum hose bending radius is six times the nominal bore of the hose. Floating hoses are designed to bend with the sea and must have tail strings of hoses without flotation where they come aboard the ships and sharper bends are possible. The hose must not chafe or pinch between the two vessels. Chaffing gear should be fitted if chaffing is observed. Pinching is a symptom of inadequate or improperly rigged hose saddles.

When fenders are rigged from a support vessel it is common practice to bring the hoses to the site in the same vessel and pass them to the receiving ship. Upon completion of the transfer, hoses are normally left aboard the casualty and picked up from her by the support vessel before the latter's recovery of the fenders.

5-2.3 Inert Gas. Inert gas systems are important in salvage and emergency transfer operations as either a tanker safety system or a firefighting unit. In salvage and emergency transfer operations, inert gas systems:

- Fill ullage spaces of cargo tanks to prevent the tank atmosphere from entering the flammable range during transfer operations.
- Provide an inert atmosphere in the ullage spaces of tanks where there is a danger of sparks from hull damage.
- Reduce the oxygen content in holds already afire or where cargo has been heating.

Good inert gas should have:

- No soot.
- No solid particles in suspension.
- Negligible traces of SO_2, NO, and NO_2.
- Minimum residues of O_2, CO, and H_2.

Crude oil tanks should always be inerted during emergency transfers. It is desirable to inert product tanks. Some products, including some jet fuels, are color-critical and there is the possibility that even slight contamination by soot from the inert gas will make the product valueless or useless. Before inerting a product tank that is not normally inerted, technical advice should be sought, and the effect of failure to inert on the safety and success of the salvage operation analyzed.

If the casualty's inert gas system is inoperative, inert gas may be supplied from portable inert gas generators.

The Navy does not maintain inert gas generators in its inventory, but the Supervisor of Salvage can arrange for them to be provided. Figure 5-1 is a schematic of a typical inert gas generator; Figure 5-2 illustrates a typical portable unit. Table C-16 in Appendix C features an example of typical commercially available portable inert gas generator. Gas may be delivered to the tanks with any type of hose. Hose ranging from wire-reinforced plastic clothes dryer hose to spare fire hose has been used successfully.

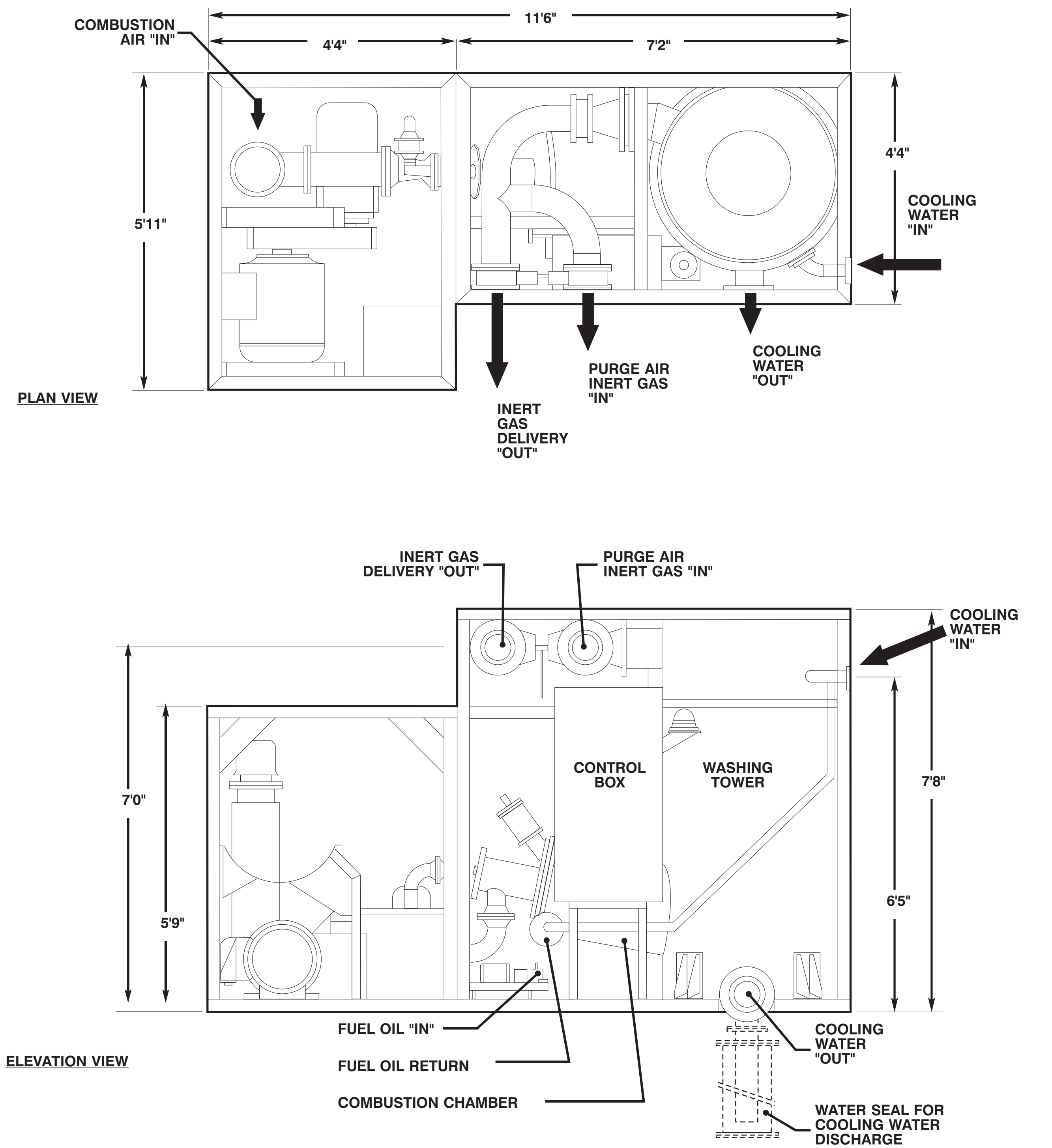


Figure 5-2. Typical Portable Inert Gas Generator.

Portable inert gas generators burn marine diesel oil and, when operating as designed, produce inert gas with only 0.50 percent oxygen by volume, traces of carbon monoxide, and no measurable soot. Because combustion is occurring in the inert gas generator, it is a potential ignition source for flammable vapors. The inert gas generator itself should be located on the forecastle or stern or on a ship alongside—well clear of areas where flammable gases are likely to collect.

Many ships are fitted with 10-inch (250 millimeter) nominal-pipe-size bolted flanges on the inert gas main for connecting emergency inert gas supplies. The flange is isolated from the inert gas main by a valve and is forward of the non-return valve. In the absence of such a fitting, considerable ingenuity may be required to adapt a portable system to inert gas main piping. It is usually worth the effort.

Inert gas is heavier than air at the same temperature. Whenever possible, inert gas should be introduced low in a space and the space should be vented at the top. The vent should be as far as possible from the introduction point. Vented gases should be led as high as possible and away from accommodation areas, engine room intakes, and portable diesel and electrical salvage machinery. Neither flammable vapors nor oxygen-deficient inert gas should be allowed to collect on deck. With winds of more than 5 knots, gases dilute to a safe level 15 to 30 feet from the vent; with winds above 10 knots, gases disperse quickly enough to be of no concern.

The oxygen discharge from the vent should be checked frequently and logged. Oxygen levels in inerted spaces should be kept below eight percent.

5-2.4 Tank Cleaning. Heavy, viscous products can become too thick to pump at low temperatures. At low temperatures, it may be necessary to heat heavy cargoes to reduce their viscosities to pump them. In a casualty, POL temperatures depend upon the ambient conditions, the status of heating systems and whether the tanks are intact or leaking. When tanks are leaking, the product temperature falls rapidly to the ambient sea temperature. Small tanks cool faster than large-volume tanks because of the higher ratio of surface area to volume. The cooling rate increases as the volume of POL in the tank decreases. Because of the large number of variables that cannot be measured with any accuracy, no guidance on cooling rates can be provided. Cooling rates for a particular situation may be determined empirically on the scene by maintaining a time-based temperature log. As cargo cools and becomes more viscous, transfer rates become very low; eventually the cargo becomes unpumpable. Transfer of cooling, viscous cargo should be expedited to move the maximum amount before the product becomes unpumpable. Work on heating devices should go forward concurrently.

Vessels carrying viscous POL normally have permanently installed steam lines or coils in their tanks to keep the product in its proper temperature range. These systems heat the product with saturated steam from the main boilers or from a separate waste heat or auxiliary boiler. If the main propulsion plant is inoperative, it may be practical to make the heating system operational with the auxiliary boiler. Otherwise, portable steam generators may be brought on board or operated from a ship alongside and steam supplied to the installed steam coils. Steam generators should supply a minimum of 1,000 pounds of steam per hour; larger quantities are desirable. The portable steam generator in the ESSM System, and described in Appendix C, provides substantially more than this amount.

If steam coils in the tank are damaged or leaking, the product must be heated by emergency means. Emergency tank heating systems include portable heating coils lowered into the tank, or hot water or steam passing through loops of Butterworth hoses lowered into the tank.

When oil is to be pumped some distance after being removed or stripped from a tank, it may be necessary to heat it again on deck or use an Annular Water Injection (AWI) Kit (ESSM Number KT0860) to sustain pumping operations (See Appendix C). Suitable heat exchangers may be found in the machinery spaces. These exchangers may be taken out of their position, brought on deck, and piped to receive oil and steam. Fuel oil heaters are particularly good candidates for this service. Alternatively, simple heat exchangers may be fabricated on site. To ensure the transfer rates are maintained through the system, transfer lines should be heated or insulated to keep the product temperature up. Transfer lines can be wrapped with steam coils or electrical heaters and covered with insulation. When transfer lines are short, insulation alone may be sufficient to maintain POL temperatures.

It is difficult to estimate with any accuracy the time required to raise product temperatures. Bringing the contents of a tank to a specific temperature depends on the mass of the product, method and amount of heat delivered, ambient temperatures, the desired temperature increase, the capacity of the product to retain heat, and the tank location in the ship. With emergency heating systems, it is also very difficult to estimate the quantity of heat delivered to the tank. The only practical way to estimate heating rates for a particular operation is to measure the temperature rise in one tank and apply the results to other tanks. When extrapolating data in this manner, only approximate results can be expected. The time required to raise the temperatures of large quantities of POL may be great. Transfer operations should not be delayed waiting for cargo temperatures to increase, but should proceed even though the transfer rate is quite slow.

All tank heating systems are closed systems. No open-ended steam lines should be placed in a POL tank, nor should steam be allowed through a leaking installed system. Live steam is electrostatically charged and is a potential ignition source if introduced into a vapor-laden atmosphere.

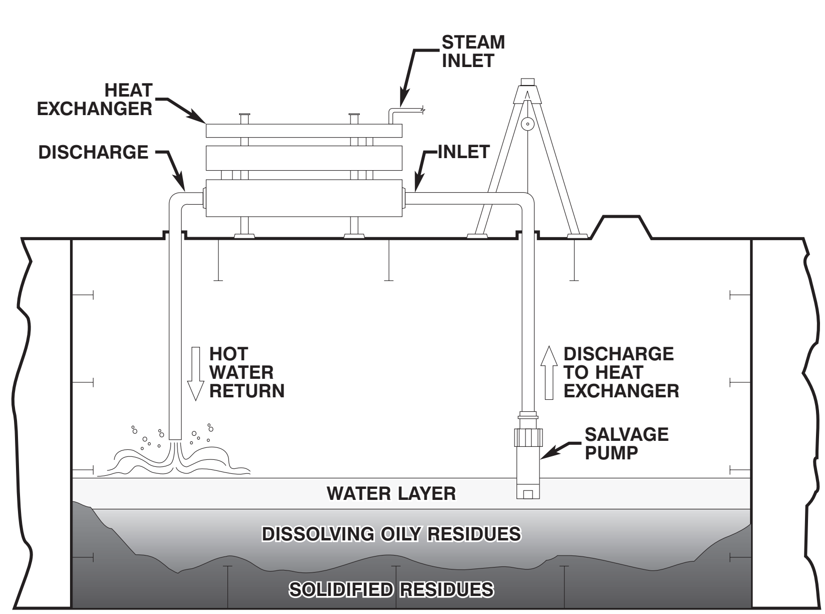


Figure 5-3. System for Heating and Removing Residues.

Sometimes salvors are required to strip all possible clingage, slops, and residue from tanks before the ship can be recovered or is allowed to enter port. Seawater may be flooded in on top of the residue and circulated to a heat exchanger on deck by a salvage pump. Steam may be injected into the seawater directly or the water may be heated in a heat exchanger. The seawater is then returned to the tank to raise the temperature and reduce the viscosity of the residues so they may be pumped. Figure 5-3 illustrates such a system.

5-2.5 Communications. Operational communications between vessels should be Very High Frequency (VHF) or Ultra High Frequency (UHF) radiotelephone in an intrinsically safe mode. Intrinsically safe radio operation in portable hand-held transceivers should be used in areas that may contain concentration of explosive vapor. The use of cellular telephones must be suspended if the possibility of explosive vapors may be present. All key personnel on both ships should be equipped with radios; the radios are operated on the same frequency as directed by the salvage officer. The power output of VHF and UHF radios should be one watt or less. Low-, medium-, and high-frequency radio transmissions are normally secured during POL transfer. Emergency communications systems should be via satellite communications. Satellite systems normally operate at 1.6 Ghz at power levels that do not normally present an ignition hazard. Transmissions should be limited to essential traffic.

Radars aboard the transferring ships do not normally present ignition hazards. However, radars should be placed in stand-by mode to reduce the potential for inducing currents in non-shielded conductors.

If voice communications between vessels fail during transfer operations, the affected vessel sounds "Kilo" on her whistle and hoists the "Kilo" flag (Figure 5-4) that signifies “You should stop your vessel instantly because, I wish to communicate with you”. Operations are suspended until communications are reestablished.

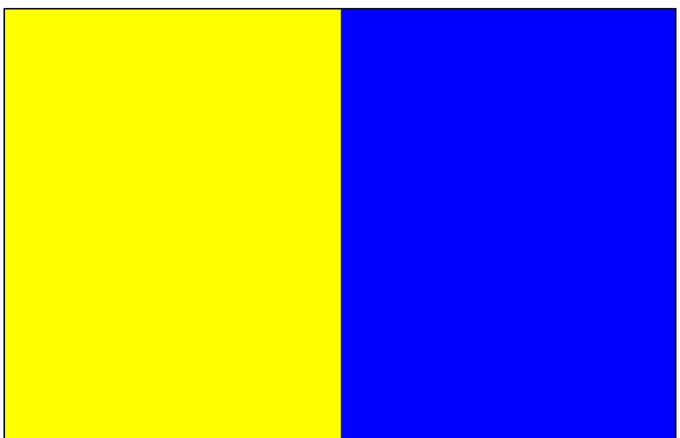


Figure 5-4. “Kilo” Flag.

5-2.6 Manning. Salvage personnel are expected to be familiar with—but not expert in—tanker operations and safety. The salvage team should include a Safety Officer who has detailed knowledge of tanker operations and safety. The Safety Officer should be free to give his undivided attention to supervision of the safety aspects of cargo transfer operations.

There must be sufficient personnel to maintain a full cargo transfer watch on each ship throughout the transfer operation. The cargo transfer watch on each ship should consist of at least one officer and enough sailors to perform the watch tasks. This watch is in addition to navigation and engineering watches. Watches should not be doubled up. Both salvage crew and ships' crews make up the watch depending on the task. The watch duties include:

- Carrying out transfer operations in the cargo control room and on deck.
- Gauging and sampling.
- Watching and adjusting mooring lines, fenders, and gangways.
- Monitoring and adjusting cargo transfer hose strings.
- Operating installed shipboard equipment.
- Operating portable salvage machinery and equipment.
- Atmospheric monitoring.
- Spill prevention.
- Safety.

Taut watches should be stood. The salvage officer should make frequent random rounds and ensure all watches are being properly stood. He should be particularly alert for slackness on the receiving ship where the operation may be perceived as a routine loading operation. If the transfer is being made in a standoff mooring, an assistant salvage officer should be stationed aboard the receiving ship.

5-2.7 Gauging. Oil handled during emergency cargo transfers has great commercial and military value that must be retained. Value is measured by both the quantity of the oil and its quality. The quantities of oil transferred must be gauged on both the casualty and the receiving ship and agreement reached on the amount. The quality of the oil should be maintained throughout the transfer and contamination prevented as much as possible.

Oil in casualties has a tendency to migrate. All tanks, including segregated ballast tanks, should be gauged as part of the initial survey. Oil samples should be taken and all tanks checked for water bottoms or the presence of water.

Tankers with inert gas systems have closed or automatic ullage systems. With these systems, it is not necessary to open ullage openings. In casualties, automatic ullage systems may be inoperative or questionable. In these cases, readings from automatic ullage systems should be backed up manually. Persons taking manual ullages should be aware that fumes in the tanks will vent and should always stand 90 degrees to the direction of the wind from the ullage opening.

Accurate ullages must be taken in each tank in both vessels before beginning the transfer. The ullages should be taken in the presence of a cargo surveyor, or owner's or type commander's representative. Temperatures of the oil should be recorded. Measurements should be recorded in both gross and net units.

Tanks should be gauged regularly during the transfer operation. It is particularly important to gauge tanks after shifting offloading or loading to a new tank to determine if oil is actually being taken from or loaded into that tank. All tanks should be gauged on the casualty to determine if there is free communication between tanks. Where free communication between tanks exists, changes in hull stress that occur with simultaneous offload of the tanks in free communication should be determined.

Upon completion of the transfer, another complete set of ullages should be taken, all corrections applied, and the amount transferred agreed upon.

The receiving vessel's tanks should be inspected and passed as fit for the particular product being received as part of the procedure for accepting the receiving vessel. This inspection should not be waived except under the most severe conditions. If waiver is necessary, the amount and type of residue in each tank should be recorded.

Samples from the casualty's tanks should be taken and checked for contamination before and during the transfer. Samples may also be taken at the cargo pump. A sampling bleeder is found just off the casing on the discharge side. By sampling at the cargo pump, breaching the inert gas integrity of the tank is avoided. All samples should be retained.

5-2.8 Explosive Gas Buildup. During transfer operations, enough gas may flow from the tank vents to form explosive mixtures in the atmosphere. If these mixtures reach an ignition source they can explode. Gas venting from the tanks of the receiving vessel are a major source of explosive vapors, but vapors may also originate on the casualty. The vapors issuing from the vents of the receiving ship or barge are likely from previous cargo (up to 3 prior) rather that the product being transferred, unless the tanks were cleaned. The presence and proper use of an inert gas system does not completely eliminate the possibility of explosive vapors existing in the atmosphere. Most vapors are heavier than air and will settle along the deck and in other low areas. In ship-to-ship transfers, explosive mixtures are especially likely to accumulate in the relatively poorly ventilated space between ships. The potential presence of vapors requires four things:

- Control of ignition sources.
- Monitoring.
- Dispersion.
- Barriers.

Ignition sources should be restricted in areas where vapors are likely to exist or accumulate. Diesel-driven salvage machinery, portable inert gas generators, steam generators, and other such equipment are best sited on salvage ships alongside. If it must be placed on board the tanker, it should be clear of the tank deck on the stern or forecastle, and upwind of vents or openings where vapor concentrations are likely. Any equipment that is a potential ignition source, whether aboard the tanker or a salvage ship alongside, should be shut down at least every twenty-four hours and the exhausts blown through with compressed air to remove carbon build up. If the fuel is dirty or low-grade, the interval should be reduced. Machinery should be operated within design conditions. A watch should be set on all operating portable machinery.

Areas where gases might accumulate should be monitored frequently with suitable gas-detecting instruments such as those described in Paragraph 5-2.12. Areas of particular concern are the lees of deckhouses and structures, the break in the forecastle, and the gap between the ships. Special attention should be paid to the areas around ignition sources.

Gas rises from vents or leaks in a plume that bends to leeward and settles downward. The plume of gases is diluted by the atmosphere until the explosive gas content is below the Lower Explosive Limit. The process is aided by wind. The higher the wind velocity, the more quickly the vapors disperse. At wind speeds of 10 knots and above there is little risk from explosive gases in the open, but the possibility of gas pockets developing in the lee of structures remains. Portable blowers for dispersing fume should be intrinsically safe and not a potential ignition source themselves.

Doorways, ventilation intakes, and ports into the accommodation, engine room, pump rooms, and other portions of the interior of the ships should be kept closed to form a barrier to vapors. Doors for personnel transit should be designated and should be closed as soon as transfers are complete. Air conditioning systems should be in the recirculation mode.

When a concentration of explosive vapors is detected, the transfer operation should be secured. Transfer should not resume until the vapors have dispersed.

5-2.9 Stray Electric Charges and Currents. Static electricity is generated during normal and emergency offloading, most commonly by friction between a pipe and a flowing product or by internal friction in the product. Because of their low conductivity, the problem is most severe in products that are static accumulators. Products may pick up a static charge from flow, when sprayed or splashed against a metal surface, as a cargo first entering a tank, from solids or non-mixing liquids settling through the oil, or by rubbing and sudden separation of synthetic polymers—such as synthetic fiber line and gloves. Charge generation and accumulation increases as the rate of flow increases, as the agitation in the tank increases and as the amount of entrained water increases. Charged products are sources of ignition. Explosions occur when all the following conditions are met:

- A static charge is generated.
- Enough static electricity has been generated to cause an incendiary spark.
- There is a spark gap.
- The atmosphere in the spark gap is explosive.

The accumulated static charge may be kept too low to produce an incendiary spark by low initial and maximum flow rates. Spark gaps may be eliminated by excluding foreign objects from the tanks and by delaying manual ullaging until the static charge is dissipated. A properly inerted tank cannot contain an explosive atmosphere.

Entrained water is of particular concern in emergency offloading operations. A large petroleum transfer with entrained water may generate a large static charge from friction between the oil and water. Charging may be limited by keeping transfer velocities low and minimizing the drop into the receiving tank.

Static charges dissipate with time. Normally, a relaxation time of 30 minutes is enough time for a static charge to dissipate.

Oils that have high internal conductivity present less of a danger than those oils that are static accumulators. Oils with high internal conductivity include: crudes, residual fuels, black diesel oils, and asphalts. Clean oils (distillates) have low internal conductivity and require antistatic procedures unless the tanks are inerted.

During the initial loading when there is considerable splashing and turbulence, flow velocity of static accumulator oils should be kept below about three feet per second. Table 5-1 gives flow rates in gallons per minute that correspond to a flow velocity of three feet per second for various nominal pipe sizes.

Large electrical currents can flow through conducting pipework, hoses, or mooring lines between ships and between ship and shore. The currents result from DC-impressed current or sacrificial anode cathodic protection systems, galvanic potential differences between ships or between ship and shore, or current leakage from electrical power sources or equipment. The currents may cause incendiary arcs if the current path is interrupted suddenly, as when hoses are disconnected.

Table 5-1. Flow Rates for Flow Velocity of 3 ft/sec.

Pipe or Hose Diameter (inches)	Flow Rate (GPM)
3	75
4	128
6	295
8	510
10	805
12	1153
14	1408
16	1866
18	2385
20	2974
24	4342
* Calculations for pipe or hose that are not present on this table use Q=VA. Q = Flow rate, V = Velocity (ft/s), A = Cross sectional Area (ft^2).	

When transferring oils that are not static accumulators, ships are isolated electrically from one another by using nonconducting mooring lines and nonconducting hose, or by inserting an insulating flange in the hoseline. Impressed current cathodic protection systems are shut down to minimize electric charge buildup. When transferring oils that are static accumulators:

- There should be an insulating flange or length of nonconducting hose between the ships. Care must be taken to ensure that nonconducting and conducting hose lengths are not mixed or more than one insulating flange used—this would permit an electrically insulated length of conducting hose to build up a static charge.
- Properly operating impressed current cathodic protection systems should remain in operation when both ships have impressed current systems or if one has an impressed current system and the other a sacrificial anode system.
- Impressed current systems should be shut down if one ship has no cathodic protection or either impressed current system is not operating properly.
- All equipment for ullaging, sampling, or dipping should be nonmetallic or should be properly bonded and grounded.
- Only ***natural*** fiber lines should be used for lowering equipment into tanks.

5-2.10 Pollution Control. There is always a risk of oil spills during cargo transfers. When the transfer is an emergency, conducted by out-of-the-ordinary methods and procedures, the risk of a spill is increased. Pollution prevention measures include:

- Ensuring that transfer hoses are properly supported by saddles and that support lines are stopped off on cleats, not left on winches or capstans.
- Ensuring that hose strings are made up properly with new gaskets and locked, pinned, or lashed couplings.
- Blocking all scuppers so that spilled oil does not flow over the side, and making arrangements for drainage of rain accumulation.
- Having quantities of sawdust, peat moss, sorbent pads or mats, available for immediate application to spills.
- Taking frequent ullages or soundings.
- Ensuring relief valve settings are correct.
- Constant attention to places where spills may occur and to practices that may set up a spill.

Oily sawdust and sorbents spread to clean up spills should be disposed of immediately. Spillage between ships should be covered by a layer of foam to reduce the risk of ignition from sparks generated by wire ropes supporting the fenders scraping along the hull, sprayed with approved detergents, and agitated with water jets. All spills must be reported to the appropriate authorities.

Whenever practical, transfer operations should be boomed. Gates should be provided in the boom to allow boat traffic. Booms are appropriate in calm or sheltered waters when vessels are stationery. They are not appropriate when the transferring ships are underway or drifting. Boom and skimmers at the scene of any transfer operation are a good investment. No hard and fast rules can be made for determining the amount and type of pollution control equipment at any transfer site. The risk of pollution, environmental sensitivity, and requirements of local authorities all enter into the equation.

The transfer operation should be secured whenever a spill occurs. Transfer should not be resumed until the spill has been cleaned up and the FOSC has assessed that the spill has been remediated successful and further actions have been put in place to prevent further discharge. Guidance for response to oil spills appears in the *U.S. Navy Ship Salvage Manual, Volume 3,* S0300-A6-MAN-030.

5-2.11 Boat and Helicopter Operations. Boat operations during transfers should be limited to those that are operationally necessary. No unnecessary craft of any sort should be allowed alongside either ship. Boats in the vicinity should be considered as potential ignition sources. Safety precautions to reduce ignition sources should be enforced on boats in the vicinity as they are on the tankers.

Helicopter operations should be permitted over the tank deck only when all transfer operations have been secured and all cargo tank openings closed.

5-2.12 Salvage Equipment. Major equipment for over-the-top transfers are described in Paragraph 5-4 and in Appendix C. In addition to this equipment salvors should bring several special items of safety equipment to all emergency transfer operations. This equipment is for the protection of the salvors and to help avoid mistakes while handling cargo. Many of the items can be found aboard the tankers, but the salvors should have their own to be sure they have equipment that is in operable condition, rigged like they want it, and that is equipment they know. Much of the equipment is not available through the Federal Stock System, but can be purchased commercially. The equipment and its purpose in the operation includes:

- **Explosimeter** – To indicate the presence of flammability of atmospheres. This is a single function device. It does not indicate the presence of toxic gases or if the atmosphere can support life.
- **Oxygen Analyzer** – To measure the oxygen content of an atmosphere to indicate if it has enough oxygen to support life and to measure the oxygen content of inerted tanks atmospheres and of inert gas.

- **Multi-Gas Detector** – To detect the presence of dangerous concentrations of hydrogen sulfide, and the presence of carbon dioxide, carbon monoxide, nitrogen dioxide, and chlorine—all of which may be present aboard a tanker. Many multi-gas detectors are available that incorporate an oxygen analyzer and an explosimeter/combustible gas indicator.

- **Anemometer** – To measure the wind velocity across the deck and in sheltered locations. Air movement across the deck is critical to dispersal of toxic and explosive fumes. Normal flow patterns are changed by ships alongside.

- **Interface Detectors** – To detect the presence of water bottoms in cargo and bunker tanks. All tanks should be checked with both interface indicators and water-indicating paste.

- **Linen Ullage Tapes** – In place of metal ullage tapes as a safety measure in a salvage situation.

- **Hand-Held Transceivers** – Intrinsically safe portable hand-held UHF transceivers fitted with intrinsically safe rechargeable battery packs for communications within the salvage team and with the ships.

- **Loud-Hailer** – One intrinsically safe portable loud hailer for communicating on deck when radio communications are for any reason unavailable.

- **Breathing Apparatus (SCBA)** – Air-supplied or closed circuit oxygen SCBA similar to those discussed in *U.S. Navy Ship Salvage Manual, Volume 1,* S0300-A6-MAN-010 and in *Naval Ship's Technical Manual, Chapter 555, Volume 1 (Surface Ship Firefighting),* S9086-S3-STM-010 for entering spaces with nonbreathable atmospheres. The Oxygen Breathing Apparatus (OBA) is not suitable for this purpose as the heat generated by the oxygen production process is a potential ignition source. For a complete description of all Navy personal protection equipment, see NSTM Chapter 077.

- **Protective Clothing** – Either the fireman's outfit or the salvage firefighter's outfit described in *U.S. Navy Ship Salvage Manual, Volume 1,* S0300-A6-MAN-010 and in *Naval Ship's Technical Manual, Chapter 555, Volume 1 (Surface Ship Firefighting),* S9086-S3-STM-010 should be available for working helicopters, handling toxic hydrocarbon, and firefighting.

- **First Aid Kit and Resuscitator** – Tankers will have first aid kits and resuscitators on board, but salvors should bring emergency medical equipment and supplies of known condition and with which they are familiar.

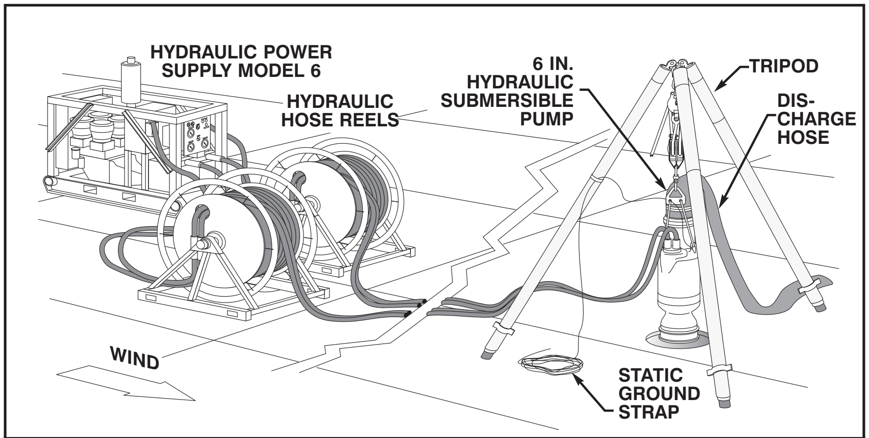


Figure 5-5. Hydraulic Pump and Power System.

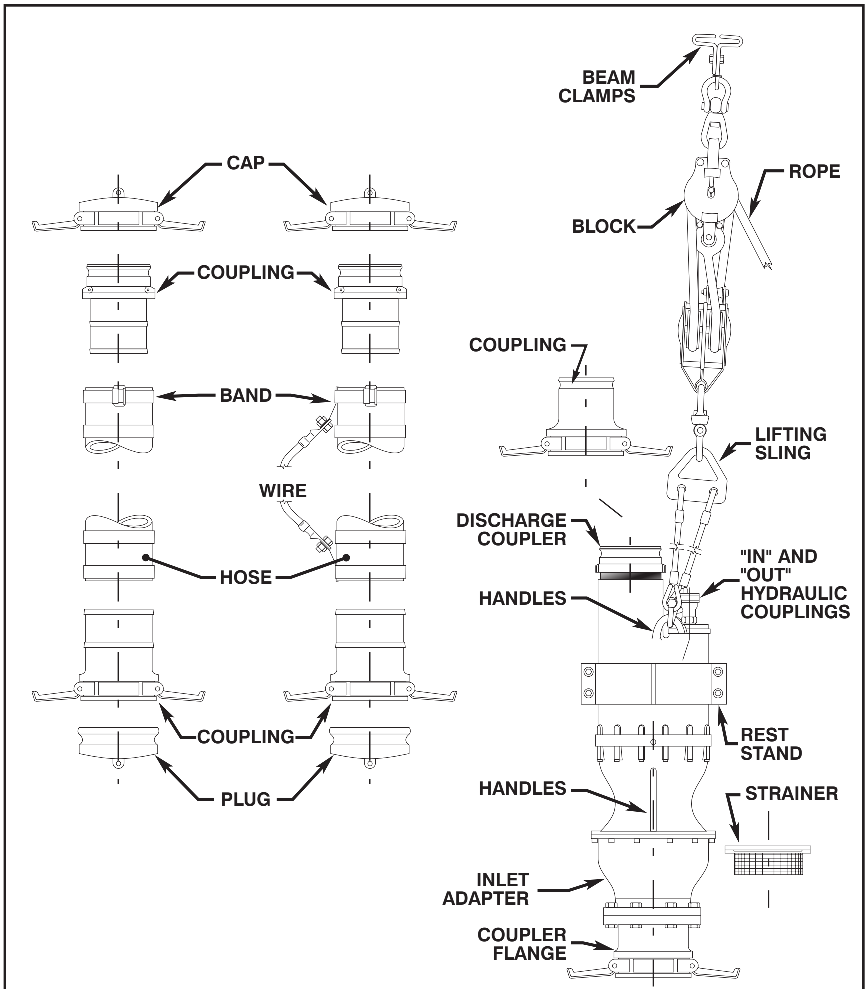


Figure 5-6. Hydraulic Submersible Pump and Hose Subsystem.

- **Rescue Stretcher** – Set up as the salvors and helicopter operators prefer.

- **Nonsparking Hand Tools**.

5-2.13 Securing. Both ships should be prepared to secure the operation at any time. The consequences of an accident are so severe that the operation should be shut down whenever:

- Conditions deteriorate beyond those established during the operational planning.
- Electrical storms are in the vicinity.
- Key equipment fails.
- There is an emergency.
- There is any doubt about the operation.

To facilitate shutting down, all tools and equipment, especially tools for breaking the transfer hose connections and axes for cutting the fiber rope tails of mooring lines, should be on station. If the receiving vessel is a barge, a tug should be standing by to move it clear on immediate notice.

- The operation is secured normally upon the completion of all planned transfer and stripping. Normal securing includes:
- Draining all hoses into one of the ships and blowing them down with compressed air.
- Disconnecting hoses, ensuring any remaining oil drains into drip trays under the manifold and is cleaned up.
- Blanking all hoses on manifolds and hoses.
- Clearing the sides.
- Checking all mooring equipment.
- Getting underway in compliance with the transfer plan.

Hoses must be blown down carefully to avoid destroying the inert atmosphere in the tanks. When the cargo is a static accumulator, hoses should never be blown down. With these cargoes, hoses are drained into the drip trays and the drip tray contents are subsequently drained or pumped into the slop tank. As noted in Paragraph 5-2.2, upon completion of the transfer, hoses are usually left aboard the casualty and picked up from her by the support vessel. Hoses may also be left in place aboard the casualty for subsequent transfers.

5-3 EMERGENCY TRANSFERS WITH INSTALLED EQUIPMENT.

The casualty's installed cargo handling systems provide the fastest and safest method of emergency cargo transfer, because they emulate normal cargo operations. Optimally, these systems are operated by people trained and experienced in the specific systems. The casualty's crew can provide invaluable assistance to salvors during emergency transfers. Type commanders' or owners' staffs, builders, and other specialists can provide technical information and assistance.

Salvors should follow EOSS and other directives relative to operation of the transfer system that delineate systems operation, pressures, temperatures, valve line-ups, etc., as closely as practical under the operational conditions.

It is most practical to transfer cargo with installed systems when the casualty is basically intact. Damage to the hull and piping systems may require the over-the-top transfers or combined transfers that are described in Sections 5-4 and 5-5. Whenever it is possible to use a portion of the casualty's installed systems, every reasonable effort should be made to do so. Power, steam, or air needed to operate some pumps may be supplied from a salvage ship or portable sources. Small deep well and standard reciprocating pumps can often be activated relatively easily. Turbine-driven main cargo pumps that have been burned out, flooded out, or are misaligned are a serious problem. The work required to reactivate them is seldom justified. Balancing risk, time, return, and effort is an early and very necessary step in determining the practicality of reactivating shipboard equipment for a transfer with installed equipment.

5-4 OVER-THE-TOP TRANSFERS.

The casualty's transfer systems may be inoperable or ineffective because of damage to the hull or piping systems, flooding, or burned-out machinery. The transfer may be accomplished by inserting portable hydraulic pumps designed to fit through standard 12.5-inch (318 mm) diameter Butterworth openings and pumping over-the-top. An over-the-top offloading operation is an emergency method that is to be resorted to only if installed handling systems cannot be made functional. Pumping over-the-top is required from damaged tanks with pump suctions below the oil-water interface and where piping is broken.

5-4.1 Pumps. There are several types of hydraulic submersible pumps available commercially that are designed specifically for over-the-top pumping. These pumps have been designed to fit through the Butterworth opening because that opening provides clear access into the tank. The opening also limits the size and thus the capacity of the pumps. All of the pumps are powered by submersible hydraulic motors powered by hydraulic fluid provided through hoses from a diesel or electrically powered hydraulic pump. The output of the pumps are varied by changing the hydraulic flow. The pumps are placed in the tanks with the assistance of a tripod and handling system.

The standard Navy pump is the Thune-Eureka CCN-150 hydraulic, submersible, single-stage, centrifugal pump. (Although this pump and associated hydraulic power unit remain in the ESSM system, other submersible hydraulic centrifugal pumps in the system provide high capacities and head pressures that are grater and more efficient to use than the Thune-Eureka. The KMA-333, for example, can provide approximately 25% higher flow rates and 40% higher head pressures than the more outdated Thune-Eureka.) This pump is capable of pumping water, crude oils, refined products, and chemicals. The pump is stocked in the ESSM system; Appendix C gives full specifications. It is normally shipped with all accessories necessary for operation, including:

- One 60-foot length of 6-inch diameter collapsible discharge hose with quick connect (Cam-Lok) couplings.
- Five 20-foot lengths each of 5- and 6-inch rigid suction hose are also available with the pumping systems. The 5-inch hose is for pumping fluids and oils with viscosities less than 1,500 centipoise; the 6-inch hose for pumping oils with viscosities between 1,500 and 30,000 centipoise.
- One Mod 6 NAVSEA Hydraulic Power Supply.
- Lifting tripod and accessories.
- Four lengths of 100 feet each, 1-inch hydraulic hose.
- Miscellaneous fittings and hardware.

The pump and power supply system is illustrated in Figure 5-5. Figure 5-6 shows the pump and hose subsystem. As the discharge hose length must reach from the bottom of the casualty's tanks across the main deck to the discharge point, additional lengths of hose are available in the ESSM system as are additional lengths of hydraulic supply and return hose.

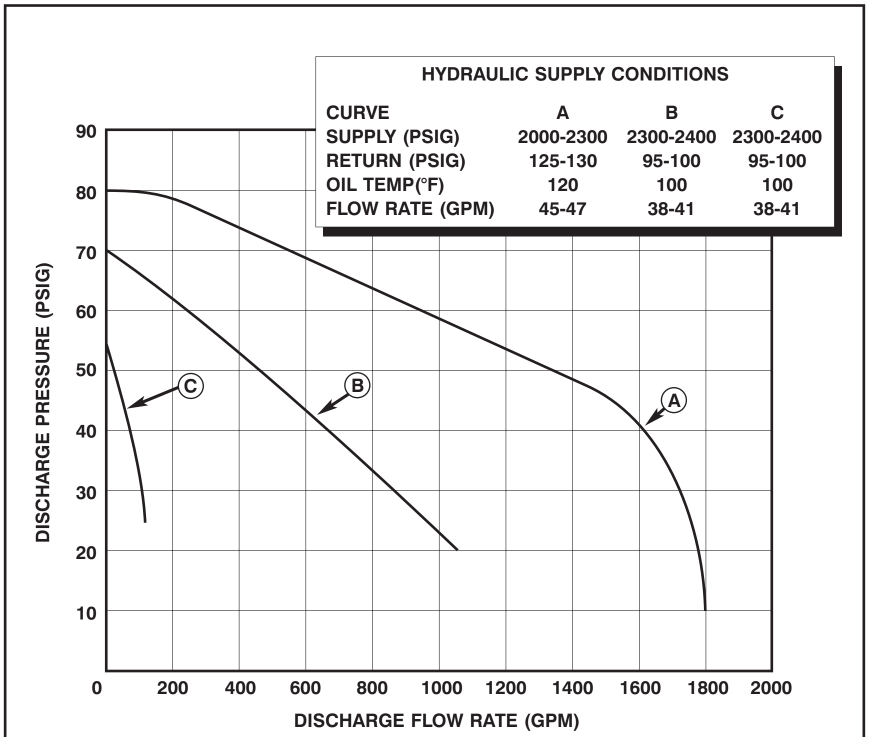


Figure 5-7. 6-Inch Hydraulic Submersible Pump Performance Curve.

Pump capacity varies with static lift and the viscosity of the fluid being pumped. Figure 5-7 is a performance curve for the CCN-150 hydraulic, submersible pump for three viscosities:

- Curve A for water (viscosity less than 2 centipoise).
- Curve B for oils with viscosity less than 1,500 centipoise.
- Curve C for oils with viscosities between 1,500 and 30,000 centipoise.

Examples of determining pumping rates with performance curves are given in Chapter 11, *U.S. Navy Ship Salvage Manual, Volume 1,* S0300-A6-MAN-010.

POL may be pumped with the *modified* Prosser 4-inch electric submersible pump. This pump is available in the ESSM System and is issued to salvage ships and units. Only the modified pump is provided with impellers suitable for pumping POL. Appendix C contains detailed information on this pump and performance curves for POL service.

5-4.2 High Viscosity Oil Removal Equipment. When petroleum cargoes constitute heavy, viscous Bunker C-type oil (HFO, IFO380), it may be necessary to switch to a positive-displacement screw pump. When oil viscosities start to exceed 20,000 cSt, the DOP-250 Archimedean screw pump and the smaller DOP-160 screw pump can be used to pump viscous oil. For situations with extremely viscous oil and/or long discharge hose pumping runs, the Navy Viscous Oil Pumping Kit can be used to increase pumping distances, decrease head pressures, and keep pumping flow rates high. Figure 5-8 shows a DOP-250 pump with VOPS annular water injection system set up on a freight-type vessel.

The double-diaphragm pneumatic pump finds widespread application in salvage defueling operations as described in Paragraph 4-3.1.6. These pumps are seldom suitable for large cargo transfers because they do not have the capacity to offload tankers in a reasonable amount of time.

Reciprocating steam pumps are suitable for pumping oil cargoes directly from the tanks or for serving as booster pumps when cargoes must be pumped considerable distances. These pumps may be operated on air but their pumping capacity is reduced.

5-4.3 Prime Movers. The prime mover for the hydraulic, submersible pump is the NAVSEA Mod 6 Hydraulic Power Unit (HPU). This diesel-driven unit provides a maximum of 50 gpm hydraulic flow at 2,500 psi, enough to operate one hydraulic pump. The unit should operate for 6 hours on the integral fuel supply.

The ESSM system also provides a larger, more powerful HPU than the Mod 6, the NAVSEA Mod 8, which uses a 250-hp diesel engine and produces 70 gpm hydraulic flow at up to 4000 psi hydraulic pressure.

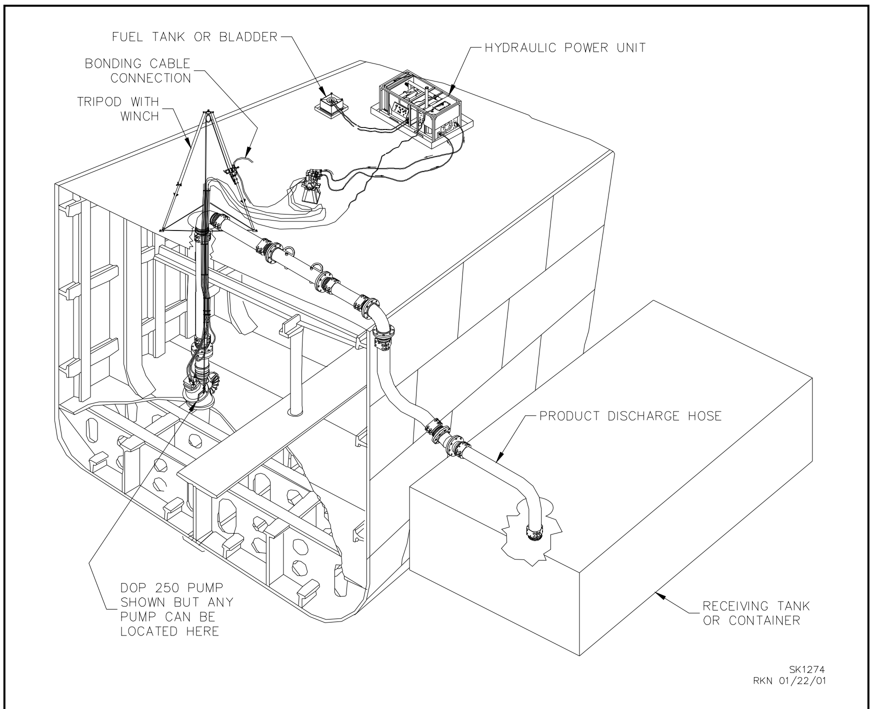


Figure 5-8. DOP-250 Pump with Annular Water Injection Shown Being Lowered to a Double Bottom Tank on a Freighter-type Vessel.

The normal prime mover for the Prosser 4-inch submersible electric pump is the 30-kw diesel-driven salvage generator. Any 220- or 440-volt 3-phase, 60 hertz power supply capable of supplying 30-35 amps at 440 volts or 60-70 amps at 220 volts is suitable.

Both the HPU and the 30-kw generator are described in Appendix C. Neither of these machines is designed specifically for service in emergency transfers from tankers. All precautions in this Manual regarding siting and reducing ignition hazards must be followed precisely.

5-4.4 Sealing Openings. Butterworth openings must be sealed around the hose and pump power leads to prevent leakage of petroleum fumes or inert gas from the tanks. A gas escape prevention collar should be placed around the discharge hose. As no collar is provided with either Navy pump, the collar should be fabricated in the field from sheet rubber or similar material wrapped and lashed around the discharge hose. Small leaks may be slowed down with rags or sheet rubber. A totally gas-tight seal cannot be expected. If there is no inert gas blanket in the tank, the gas concentration around the opening should be monitored frequently, and operations should be stopped if the concentration of fumes is dangerous. Inert gas blanketing during over-the-top pumping is practical. Inert gas should be provided by installed or portable systems whenever possible.

5-4.5 Sequencing. The tank pumping sequence is determined primarily by the urgency of pumping certain tanks and the effect of load changes on hull stresses. Portable systems introduce another factor into sequencing—the movement of pumps and prime mover units about the ship. An otherwise workable plan can translate into back-breaking work when pumps and prime movers must be moved about decks with large quantities of piping—especially on very large ships. Long or difficult movements unnecessarily tire the salvage crew. Tired crews make mistakes and get hurt. The initial sequencing plan should be walked through and revised to eliminate unnecessary pump and prime mover relocations.

5-4.6 Manifolding. With a large number of salvage pumps, it can be advantageous to manifold discharges together. A typical manifolding arrangement is shown in Figure 5-9. Several advantages from manifolding are:

- The overall discharge rate can be increased by having several pumps discharging into a single line.

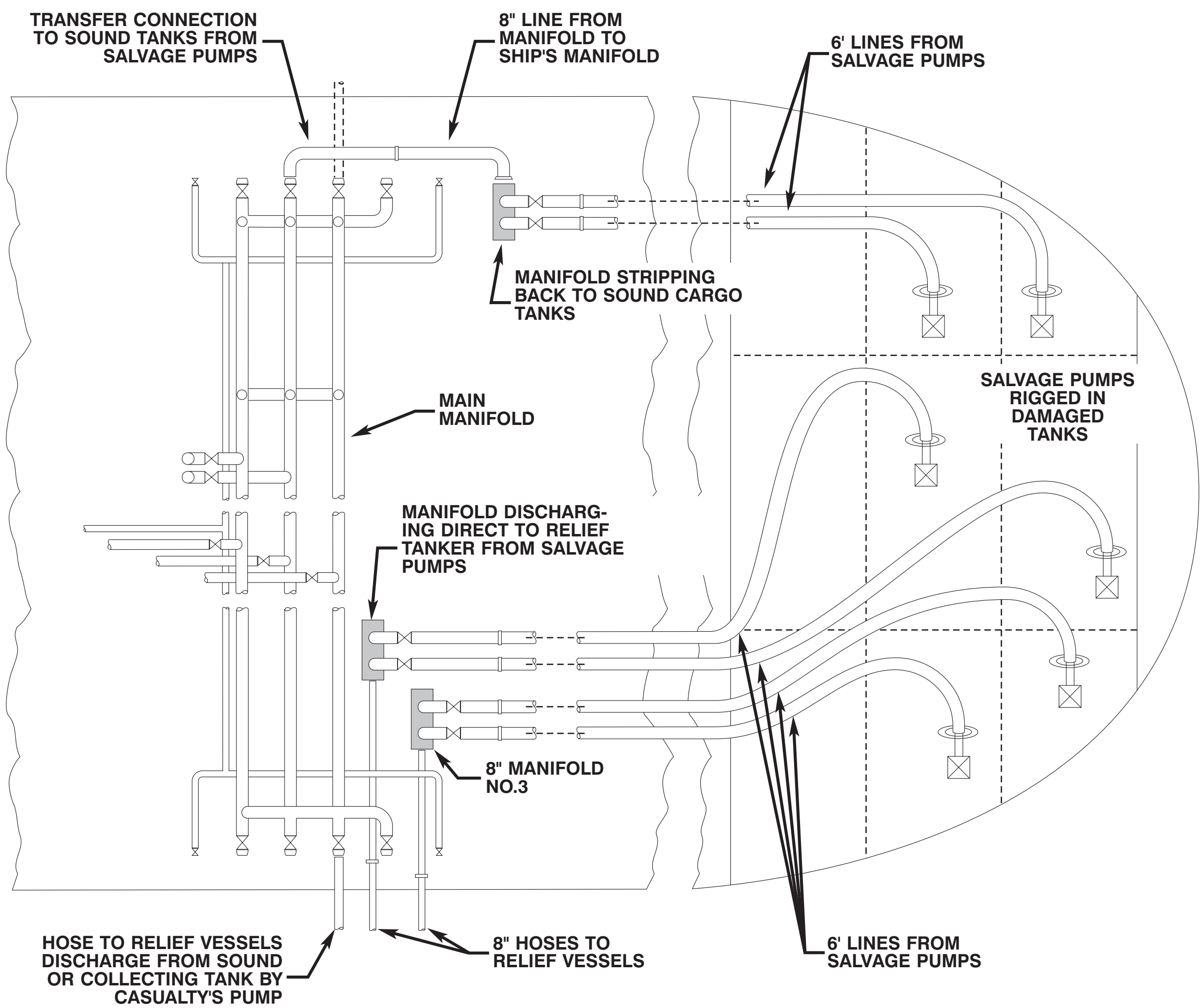


Figure 5-9. Offloading or Stripping with Manifolds.

- The number of hoses strung out on deck is reduced.

- A positive cut off is introduced between the pump discharge and the transfer hose.

Manifolds may be made up on site to fit the job.

5-4.7 Stripping. Stripping of tanks is an essential part of over-the-top pumping operations. The key part of a stripping operation is keeping the pump suction in the oil. The location of the oil-water interface should be checked at frequent intervals with the interface detector. In tanks that are not ruptured the pump can lay near the bottom of the tank during the entire operation. Pumps may begin to lose suction as the fluid level drops. Lowering the pump will keep the suction in the oil. When stripping or pumping tank washings or residues, the pump should not be allowed to tip more than 30 degrees from the vertical. If the tank can be ballasted to half its depth, the pump suction may be held in the oil and the pump efficiency will be increased by the reduced discharge head.

In tanks with a water bottom, the pump may be held fairly high in the oil because the level in the tank will remain approximately the same as the sea replaces the oil being pumped out. As the oil layer becomes very shallow, it will be necessary to raise the pump to keep the suction in the narrow layer. If the layer is narrower than the pump suction, the pump will pick up both oil and water. With careful operation of standard Navy pumps, oil layer thickness can be reduced to significantly less than one inch. Hydraulic stripping pumps and special skimming attachments are available commercially.

5-4.8 Operational Notes. The collection of miscellaneous notes in this paragraph have proven their practical value in numerous emergency transfer operations.

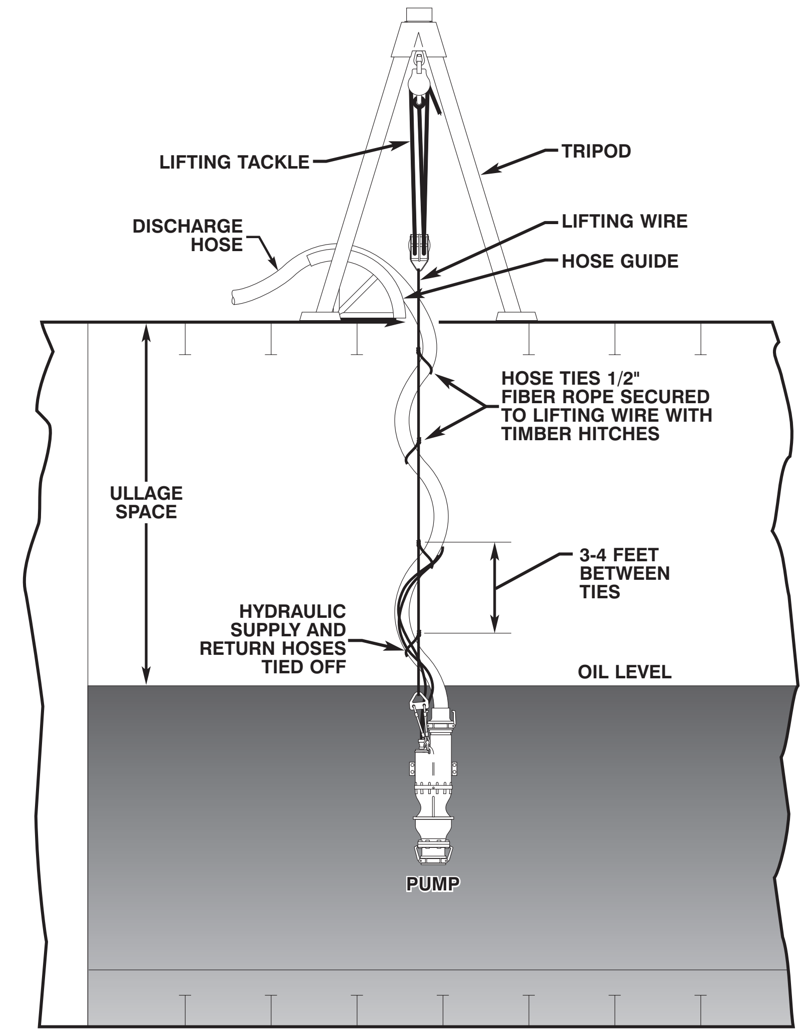


Figure 5-10. Rigging for Hydraulic Salvage Pump.

Though not a recommended or desirable practice, on occasion it may be necessary to place pumps into the tanks through the tank hatches rather than the Butterworth openings. The tank hatches are a poor second choice because, unlike the Butterworth openings, they are obstructed by the tank access ladder. Pump hoses and power leads may become fouled on this ladder. Also, tank hatch openings are much larger than Butterworth openings, and are nearly impossible to seal against fume leakage.

The pump discharge hose and the hydraulic hoses should be married to the lowering wire at three-foot intervals with timber hitches in fiber line. If the hoses are not lashed together, the hydraulic hoses may wrap around the discharge hose and collapse them. Rigging for a pump is shown in Figure 5-10.

Pumps should be secured, removed from tanks, and the tanks sealed when:

- Electrical storms are in the vicinity.

- Ships are coming alongside or getting underway.

- Pumping operations are secured for long periods.

Hydraulic pumps should not be dropped, banged, or operated lying on their sides. Pumps should not be allowed to thrash or vibrate unnecessarily in cargo tanks.

No hose guide to keep the discharge hose running fair and to avoid kinking is provided with either the 4-inch electric or the 6-inch hydraulic pump. Sandbags or 55-gallon drums may serve as hose guides, but this does not guarantee either the correct bending radius or the proper support for the hose. It is preferable to field-fabricate a hose guide, such as the one shown in Figure 5-11. The guide is set on a rubber mat and wedged against the Butterworth opening manhole to prevent the hose from flattening or kinking as it comes out of the tank.

Diesel engine-driven prime movers operating on deck should always be upwind and as far as practical from Butterworth openings through which pumps are operating.

5-5 COMBINED TRANSFERS.

In some cases, a system of over-the-top pumping of oil from damaged tanks can be combined with pumping directly from sound tanks. A stranded tanker with her forward tanks open to the sea, but her after tanks, piping systems, and machinery intact, is a good candidate for a combined pumping operation. In such a case, the oil in the forward tanks would be pumped over-the-top to the sound after tanks then pumped over-the-side with installed equipment. Figure 5-12 is a schematic of such an arrangement. Combined transfers have all the dangers, difficulties, and complexities of over-the-top transfers combined with the relative simplicity of a transfer with installed equipment. Special vigilance is required. All the comments of Paragraphs 5-4 and 5-5 apply.

Combined transfers are, in effect, two offloading and two discharge operations; the first contained in the casualty and the second a ship-to-ship transfer. The ship-to-ship transfer will proceed more rapidly than the intership transfer because the installed pumps have a greater capacity than the over-the-top pumps. To keep the operation simple and under control, it is often better to do one operation at a time, completing the over-the-top transfer and then undertaking the ship-to-ship transfer. If the crew is sufficiently large, skilled, and practiced, the two transfers may be attempted simultaneously. It may be necessary to alternate between internal (over-the-top) transfer and discharge to a lightering vessel to make onboard tank space available. Because of the seriousness of an accident, in most cases, it is better to proceed slowly, in simple steps, with the operation under full control.

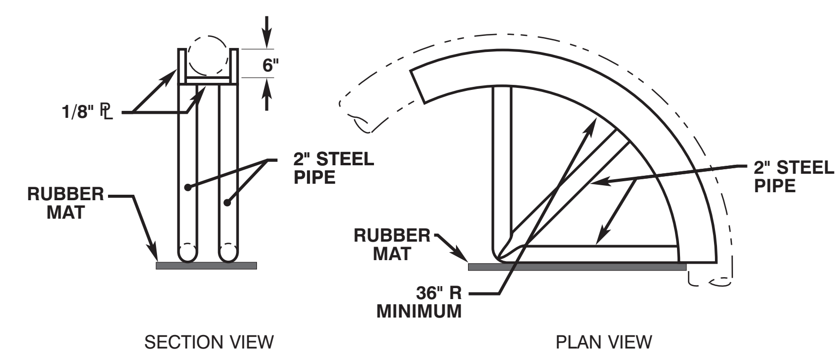


Figure 5-11. Pump Discharge Hose Guide for 6" Pump.

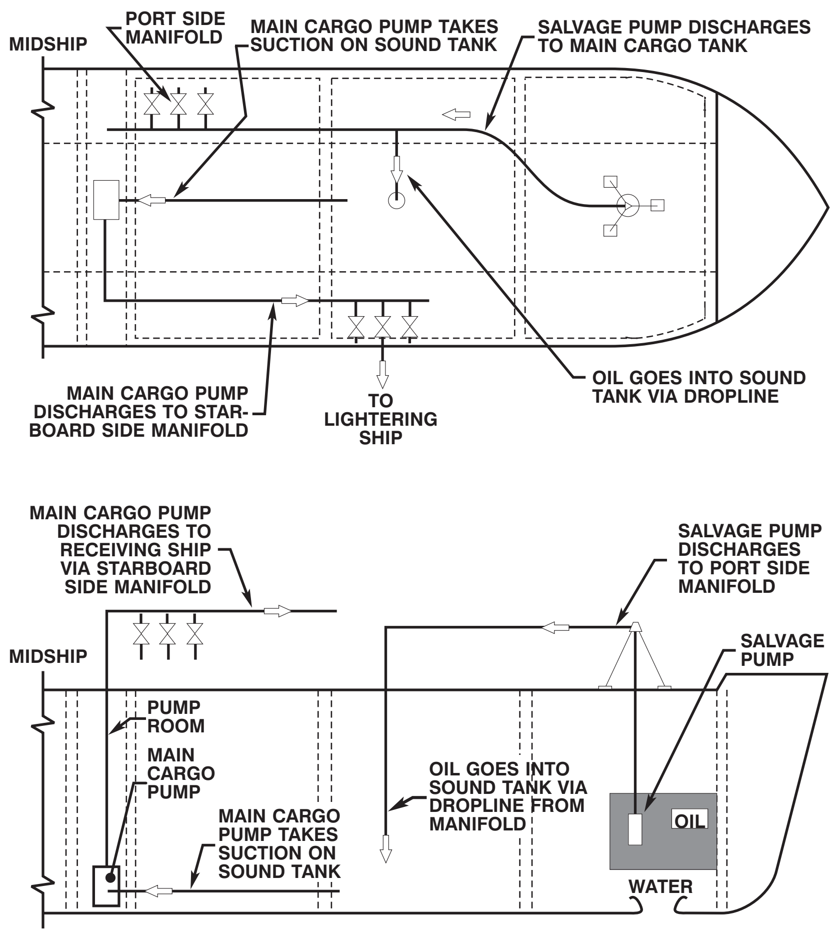


Figure 5-12. Combined Transfer Schematic.

CHAPTER 6
SALVAGE PETROLEUM OFFLOAD FOR SUBMERGED VESSELS

6-1 INTRODUCTION.

The U.S. Navy has had to remove petroleum cargoes from sunken vessels in the role of the salvor, the Federal On-Scene Coordinator and as consultant on several major events in the last decade. Due to the need for the specialized equipment used for these events, SUPSALV has developed a significant inventory of both generalized and specialized tools specifically with this type of oil recovery operation in mind.

There can be no cookbook solution to recovering oils from submerged vessels. The reasons for initiating an oil recovery operation from a sunken or submerged vessel are usually as follows:

- As a pollution abatement or pollution mitigation measure that is required in order to stem the active leakage of oil from a ship that has already sunk
- As a preventative measure to offload a ship's oil (whether cargo or ship's fuel oil) to decrease (or eliminate) the magnitude of a potential oil release in the future
- In order to support the salvage of a submerged vessel or its oil contents

The tools used to do this operation can be applied to either a vessel carrying oil as a cargo or a non-tank vessel carrying oil as a ship's fuel. The same equipment is used for either type of vessel. There is, however, additional specialized equipment required if the oil type is a low API (high viscosity) oil, such as Bunker C. See Paragraph 6-6.

Any oil removal operation of a submerged vessel is likely to involve dive teams (either commercial or U.S. Navy), although several recent incidents involved oil removal using highly technically sophisticated remote controlled equipment such as Remotely Operated Vehicles (ROVs) and support equipment such as the U.S. Navy ROLLS system. In either case, an immense amount of project-specific planning must be done prior to the operation in order to expect a high degree of success in removal.

6-2 PREPLANNING.

Goals of the planning operation must include the following:

- Survey and assessment of the sunken vessel's location
- A definitive assessment of the situational hazards, such as the following:
  - o Sea conditions, depth, currents, location-specific environmental hazards, water temperature, sharks, shipping lanes, and fishing nets
  - o Oil type, such as viscous bunker oil, medium weight black oil, and distillate oil
  - o Ongoing leakage. For example, is the target vessel currently leaking?
  - o Hull condition. For example, is the vessel in more than one piece or in multiple hull sections? What are its cargos? Figure 6-1 provides an example of a vessel that has broken into multiple hull sections.
  - o Underwater stability of the vessel and its cargos

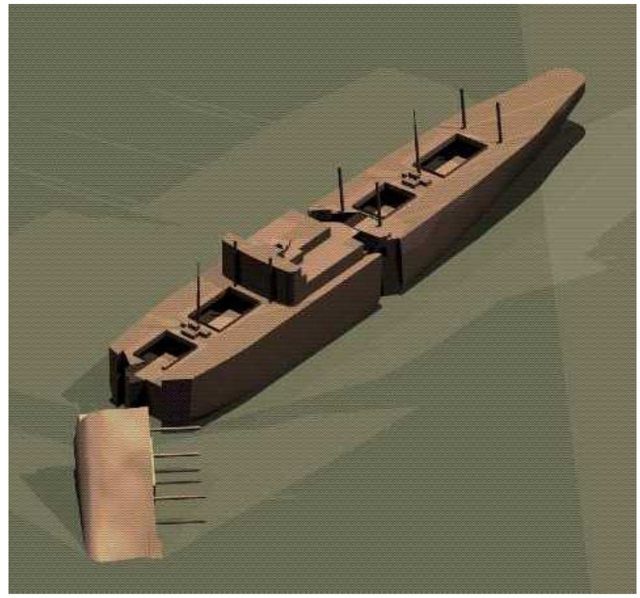


Figure 6-1. Submerged Cargo Vessel SS JACOB LUCHENBACH Shown Sitting on Bottom In Three Pieces with Bottom Debris, Silt, and Other Marine Hazards That Can Create Dangerous Working Conditions for Divers.

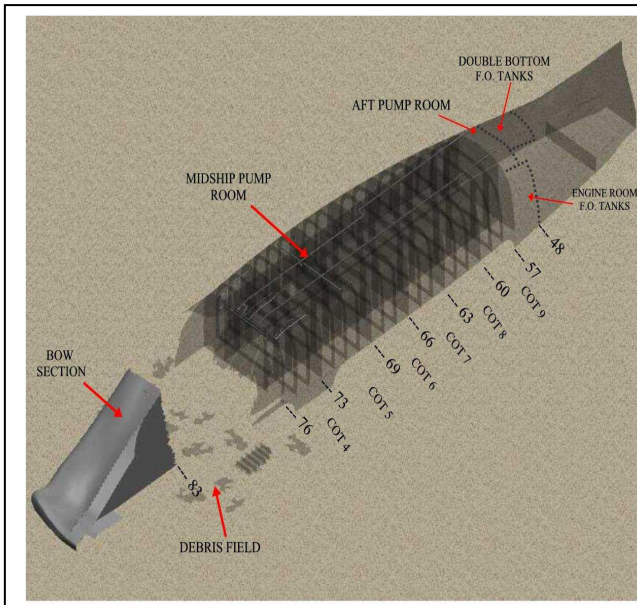


Figure 6-2. Three-Dimensional Model of Submerged World War II Tanker USS *MISSISSINEWA* as She Rests on the Bottom of the Ulithi Atoll.

  - o Attitude of the vessel. For example, is the vessel bottom side up, sitting on her keel right side up, or leaning on the port or starboard side? See Figures 6-1 and 6-2 for examples.

- o Vessel type. For example, is the vessel a tanker, barge, cargo vessel, or combatant vessel?
- Define the command and control matrix
- Determine the available assets, such as:
  - o Dive teams
  - o Dive support vessels
  - o Pollution control and response vessels, including second and third tier
  - o Recovered oil storage vessel (lighterer) or barge availability
  - o Availability of specialized equipment (hot taps, pumps, transfer systems, communication equipment)
  - o Logistics supply chain (hotel services), sanitation
  - o Air support
  - o Emergency procedures for fire, bad weather

6-3 SURVEYS AND ASSESSMENTS.

Due to the hazards of working in the undersea environment, the vessel survey becomes ever more important. Since the emergency or urgency of saving the vessel from sinking is no longer an issue, more emphasis can be placed on vessel assessment, reviewing the ship's drawings, and operational development planning. Personnel safety and environmental protection must be planned at every stage. Figure 6-3 shows some examples of a ship's drawings.

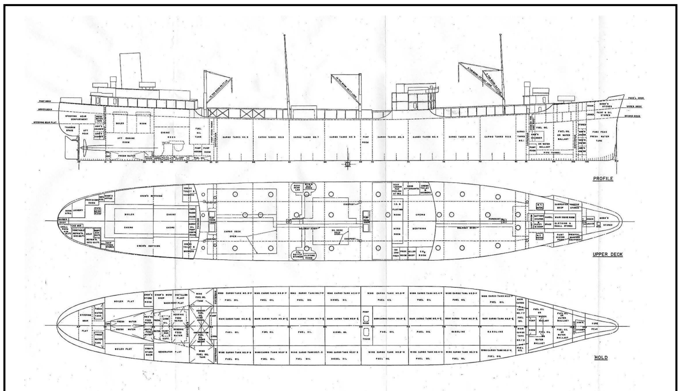


Figure 6-3. Ship's Drawings of World War II Tanker Vessel USS *MISSISSINEWA*.

The planning session should include representatives from the salvage and pollution response groups, as well as the pertinent federal, state, and industry representatives.

6-4 SPECIAL EQUIPMENT.

6-4.1 Diver Tools. Special tools that are necessary for divers to be familiar with include some of the tools most commercial and U.S. Navy divers already use. These include special down haul equipment, hydraulic drills, hot taps, valves, centrifugal pumps, and magnetic patches. Diver training on use and methodology is highly recommended using mock-up hull plates topside or ashore prior to using equipment on the bottom. Divers should also train on the use of underwater cameras and underwater observation ROVs.

6-4.1.1 Hot Tap. Refer to Paragraph 4-2.3 for descriptions of ESSM hot tap systems and their use.

6-4.1.2 Pumps. Refer to Paragraph 5-4.1 and Table 6-1 for information about pumps that can be used to offload oil from submerged vessels.

6-5 GENERAL PROCEDURE.

Using ship's drawings, ship's assessment, and vessel survey, all subject or target offload tanks should be well marked. Dive team(s) need to be thoroughly briefed on the target locations and tasks during pre-dive operations.

After determining target oil removal locations using drawings topside, surveying tanks to verify which tanks are to be tapped and pumped, the tanks must be tagged and pre-tap operations should commence, as follows:

1. All target tapping locations must be ground with underwater tools in order to remove marine growth and rust.
2. Target tank tapping locations should be tagged with a label identifying the tank and location for both the tap for the makeup water inlet as well as the offloading pump.
3. A water inlet hole should be drilled at a point below the oil level in the tank in order to allow the ingress of seawater during pumping, assuming the tank is not already open to the sea via vents or hull damage.
4. Install the hull flange onto the hull.
5. Install the valve onto the hull flange. Once air is bled off, oil can be vented to the surface. Air pockets trapped in the tank can cause damage to pumping systems. Pumping systems must be watched carefully during offloading.
6. Place submersible pumps and surface hoses into position to offload the tank to the surface. The surface hose must be configured with either a catenary or "lazy S" in order to mitigate heave stress and strain on sub-sea equipment from sea swells and tides.
7. Install hot tap system and tap the tank using the flange valve to close the tank after the tap is made. Figure 6-4 shows a hot tap system being installed.

Figure 6-4. U.S. Navy Divers Installing Hot Tap System on Hull of Submerged Vessel.

8. Connect the offloading pump or pump suction hose to the tank flange valve.

9. Open all valves and commence pumping oil to the surface, starting with very slow flow rates.

10. The tank should be pumped until the recovered oil shows that mostly water is being recovered.

11. The system should then be shut down to allow oil trapped in frames of the tank to migrate to the suction hole. Pumping should be conducted intermittently after that to remove oil that has migrated to suction. This process should be repeated as many times as it takes to remove all of the oil. Figure 6-5 shows a diagram of a freighter with oil trapped in the frames.

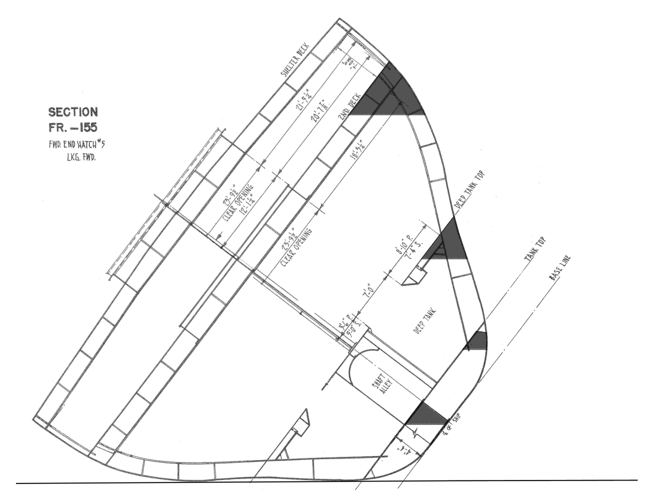


Figure 6.5. Section View of Freight Vessel with Oil That Escaped from Deep Tanks Trapped in the Upper Frames of the Vessel.

12. When the tank is deemed to be empty of oil, the tapped holes should be sealed.

This very general procedure is the basis for offloading oil from either a tank vessel or a non-cargo carrying vessel that is submerged.

6-6 HIGH-VISCOSITY OIL.

For vessels carrying very viscous oils, the addition of annular water injection to the pump suction and discharge may be necessary to pump the oil to the surface. For some oils, such as Bunker C oil (#6 or IFO380) in cold water, the tank may also need to be heated to get the oil to flow. Even if the oil will flow to the pump, it may require an annular water injection system, as well as heat, to bring pumping rates up to an acceptable flow rate without over pressurizing the offloading hose. See Figure 5-6A.

A sampling of ESSM equipment that could be used for submerged vessel oil salvage operations includes the following list of systems and components, plus the pumps listed in Table 6-1. These are not comprehensive lists:

- Submersible Hydraulic Pumping System, 2” to 6”, P17200
- Floating Hose System, P08100
- Viscous Oil Transfer System, P13200
- Hot Tap System, P10100
- VOPS Kit (Viscous Oil Pump Kit)
- Pneumatic Fenders (LP Pneumatic 14’ × 60’)
- Modular Barge System, P06400
- ROV Lightering System, P10200
- Steam Generator System, P12200
- Salvage Support Skimmer System, P16200

Other systems could include the following:

- Skimmers
- Boom Systems
- Rapid Deployment Skimmers
- Command Vans
- Bunk Vans
- Shop Vans

One common denominator for submerged vessel oil recovery is the need to be able to modify or fabricate equipment on-site during the operation. Welding, cutting, and fabrication capabilities must be available on board the response vessels. The supply chain should be able to obtain items with short notice.

Table 6-1. ESSM System Pumps for De-Watering, Ship Salvage, and Oil Transfer.
(This list represents the majority of the pumps in the ESSM system.)

ESSM #	Pump Description	Primary Function	Power Required	Max Flow Rate (gpm)	Max Head Press (psi)	Size / Wt
PUO295	Fischcon 6"	De-Water	72 gpm @ 4000 psi	2800	115	42" × 12" / 280 lbs
PUO310	KMA 333	De-Water / Lt Oil	70 gpm @ 4000 psi	2300	118	32" × 12" / 210 lbs
PUO280	Kaeverner CCN150-3C	De-Water / Lt Oil	52 gpm @ 2400 psi	2100	122	210 lbs
PUO305	Hydra-Tech S4SCR	Lt Oil & Water	15 gpm @ 3500 psi	1150	87	54 lbs
PUO835	Hydra-Tech S2T-2	Lt Oil & Water	5 gpm @ 2500 psi	180	54	26 lbs
PUO278	Kaeverner CCN150	Water	52 gpm @ 2350 psi	1900	90	300 lbs
PUO303	Hydra-Tech S3CML	Water	15 gpm @ 3500 psi	450	178	25" × 11.5" / 45 lbs
PUO850	Desmi DOP-250	Heavy (Viscous) Oil	42 gpm @ 3000 psi	440	150	27" × 35" / 210 lbs
PUO840	Desmi DOP-160	Heavy (Viscous) Oil	21 gpm @ 3000 psi	120	150	30" × 13" / 75 lbs
PO201	Barnes 3" Diesel Driven Centrifugal (skid mounted)	Water	9-hp Onan Diesel Engine, 2000 rpm	350 @ 17 psi	52	36" × 26" × 36" / 775 lbs
PUO208	Barnes 6" Diesel Driven Centrifugal (skid mounted)	Water	37-hp 2-53 series Diesel 2200 rpm (skid mounted)	1540 gpm @ 17 psi	43	65” × 30” × 48” / 3543 lbs
PO220	Barnes 10" Diesel Driven Centrifugal (skid mounted)	Water	60-hp 3-53 DD @ 1800 rpm	3000 gpm @ 13 psi	43	83” × 33” × 52” / 3200 lbs

APPENDIX A
DOCUMENTATION MATRIX

A-1 PURPOSE.

The purpose of this matrix is to provide the user of this manual with a listing of additional reference documentation. This is given by reference manual and topic area.

A-2 REFERENCE DOCUMENTS.

The following manuals/publications are referenced on the matrix (Table A-1):

- SAFETY MANUAL - U.S. Navy Salvage Safety Manual (S0400-AA-SAF-010)
- SALVAGE MANUAL - U.S. Navy Salvage Manual

  Volume 1 Stranding, Harbor Clearance and Afloat Salvage (S0300-A6-MAN-010)

  Volume 2 POL Offloading (S0300-A6-MAN-020); formerly Volume 5

  Volume 3 POL Spill Response (S0300-A6-MAN-030); formerly Volume 6; Under Revision

  Volume 4 Deep Ocean (S0300-A6-MAN-040/2K175); Under Revision

- SALVOR'S HANDBOOK - U.S. Navy Salvor's Handbook (S0300-A7-HBK-010/2K175)
- UNDERWATER CUT & WELD - U.S. Navy Underwater Cutting and Welding Manual (S0300-BB-MAN-010)
- ENGINEER'S HANDBOOK - U.S. Navy Salvage Engineer's Handbook (S0300-A8-HBK-010)
- TOWING MANUAL - U.S. Navy Towing Manual (SL740-AA-MAN-010)
- ESSM MANUAL - Emergency Ship Salvage Material Catalog (NAVSEA 0994-LP-017-3010)
- EXPLOSIVES MANUAL - Technical Manual for Use of Explosives in Underwater Salvage (NAVSEA SW061-AA-MMA-010)

Table A-1. Salvage Documentation Matrix.

		Salvage Manual									ESSM Material Catalog	
TOPIC AREA	SAFETY MANUAL	VOLUME 1 - STRANDINGS, HARBOR CLEARANCE AND AFLOAT SALVAGE	VOLUME 2 - POL OFFLOADING	VOLUME 3 - OIL SPILL RESPONSE	VOLUME 4 - DEEP OCEAN	SALVOR'S HANDBOOK	UNDERWATER CUT & WELD	SALVAGE ENGINEER'S HANDBOOK	TOWING MANUAL	EXPLOSIVES MANUAL	VOLUME 1 - SALVAGE EQUIPMENT	VOLUME 2 - POLLUTION EQUIPMENT
DAMAGE CONTROL		●				●		●				
STABILITY		●	●			●		●				
SHIP STRENGTH		●	●			●		●				
RIGGING	●	●	●	●	●	●		●	●			
ANCHORS	●	●		●		●		●			●	
STRANDING		●	●			●		●				
PULLING SYSTEMS	●	●				●		●			●	
SAFETY	●	●	●	●	●	●	●	●	●	●		
MACHINERY	●					●		●	●		●	●
EXPLOSIVES		●				●		●		●		
HAZMAT	●		●	●		●		●				●
POL	●		●	●		●		●				
OFFSHIP FIREFIGHTING	●	●	●			●					●	
TOWING: POINT-TO-POINT			●						●			
TOWING: RESCUE		●				●			●			
PATCHING		●				●		●				
COFFERDAMS						●		●				
LIFTING SYSTEMS	●	●			●	●		●			●	
POLLUTION CONTROL	●		●	●		●		●				●
PONTOONS		●			●	●		●			●	
SALVAGE PLANNING	●	●	●	●	●	●		●		●		
PROPERTIES OF MATERIALS		●	●			●		●	●	●		
CONVERSION FACTORS		●				●	●	●				
COMPUTER PROGRAMS									●			
DEEP WATER RECOVERY					●	●					●	
CUTTING	●	●					●			●		
WELDING	●						●					
CARGO OFFLOAD	●	●	●	●		●		●				

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APPENDIX B
PETROLEUM TECHNICAL DATA

Table B-1. Degrees API to Specific Gravity.

Degrees API	Specific Gravity at 15.5C	Pounds per Gallon	Gallons per Pound
10	1.0000	8.337	0.1199
11	0.9930	8.279	0.1208
12	0.9861	8.221	0.1216
13	0.9792	8.164	0.1225
14	0.9725	8.108	0.1233
15	0.9659	8.053	0.1242
16	0.9593	7.998	0.1250
17	0.9529	7.944	0.1259
18	0.9465	7.891	0.1267
19	0.9402	7.839	0.1276
20	0.934	7.787	0.1284
21	0.9279	7.736	0.1293
22	0.9218	7.685	0.1301
23	0.9159	7.636	0.1310
24	0.9100	7.587	0.1318
25	0.9042	7.538	0.1327
26	0.8984	7.490	0.1335
27	0.8927	7.443	0.1344
28	0.8871	7.396	0.1352
29	0.8816	7.350	0.1360
30	0.8762	7.305	0.1369
31	0.8708	7.260	0.1377
32	0.8654	7.215	0.1386
33	0.8602	7.172	0.1394
34	0.8550	7.128	0.1403
35	0.8498	7.085	0.1411
36	0.8448	7.043	0.142
37	0.8398	7.001	0.1428
38	0.8348	6.960	0.1437
39	0.8299	6.919	0.1445
40	0.8251	6.879	0.1454

Table B-1. Degrees API to Specific Gravity (continued).

Degrees API	Specific Gravity at 15.5C	Pounds per Gallon	Gallons per Pound
41	0.8203	6.839	0.1462
42	0.8156	6.800	0.1471
43	0.8109	6.761	0.1479
44	0.8063	6.722	0.1488
45	0.8017	6.684	0.1496
46	0.7972	6.646	0.1505
47	0.7927	6.609	0.1513
48	0.7883	6.572	0.1522
49	0.7839	6.536	0.153
50	0.7796	6.500	0.1539
51	0.7753	6.464	0.1547
52	0.7711	6.429	0.1555
53	0.7669	6.394	0.1564
54	0.7628	6.360	0.1572
55	0.7587	6.326	0.1581
56	0.7547	6.292	0.1589
57	0.7507	6.258	0.1598
58	0.7467	6.225	0.1606
59	0.7428	6.193	0.1615
60	0.7389	6.160	0.1623
61	0.7351	6.128	0.1632
62	0.7313	6.097	0.1640
63	0.7275	6.065	0.1649
64	0.7238	6.034	0.1657
65	0.7201	6.004	0.1666
66	0.7165	5.973	0.1674
67	0.7128	5.943	0.1983
68	0.7093	5.913	0.1691
69	0.7057	5.884	0.1700
70	0.7022	5.855	0.1708

APPENDIX C
EMERGENCY SHIP SALVAGE MATERIAL (ESSM)

C-1 ESSM SALVAGE AND POL EQUIPMENT.

This appendix provides a brief description of the salvage and POL equipment discussed in this volume. The following list of equipment is consolidated from both the salvage and pollution catalogs.

C-2 SALVAGE CATALOG.

C-2.1 1½-Inch Submersible Pumping System, (ESSM System Number S18600). The 1½-inch, Submersible Pumping System S18600 is primarily used as a stripping pump. The system consists of a lightweight, electrically driven, submersible pump with low profile strainer, a 1½-inch diameter discharge hose, and electrical power cable, all of which is shipped in a single container. The 1½-inch pumping system requires a 440-volt AC, 3-phase power source for operation.

System includes:

- 1 Ancillary Set, for PU0250 Pump PU0258
- 1 Pump, Submersible, 1½-Inch, Electric, 440-V AC, 3-Phase PU0250

C-2.2 4-Inch Submersible Electric Pumping System (ESSM System Number S18700). The 4-inch Electric Submersible Pumping System S18700 is used for dewatering flooded compartments or any application requiring the pumping of water. The system consists of an electrically driven submersible pump, electrical cables, discharge hose, and ancillary equipment necessary for pump system operation. The pumping system is stored and shipped in a wire basket. The pump is configured to operate with 440-volt, three-phase power, but can operate with 220-volt, three-phase AC power if converted in accordance with NAVSHIPS manual 0994-004-2010.

System includes:

- 1 Pump, submersible, 4-inch, electric, 220/440-VAC, 3-PH, PU0240
- 1 Ancillary set PU0241

C-2.3 4-Inch Submersible Pumping System, (ESSM System Number S18800). The 4-inch Hydraulic Submersible Pumping System S18800 consists of two configurations to allow flexibility for on-site pumping requirements: the Single Pump Configuration and the Double Pump Configuration. The Single Pump Configuration contains a 4-inch, hydraulically driven, submersible pump, an ancillary set, a hydraulic power unit with spare parts kit, and a hydraulic hose reel assembly with hoses. This system is capable of pumping up to 925 gpm to dewater or counterflood compartments for ballast and stability or for any application where a lightweight submersible pump is needed. The Double Pump Configuration consists of two 4-inch, hydraulically-driven, submersible pumps, an ancillary set, a hydraulic power unit with spare parts kit, and a hydraulic hose reel assembly with hoses. This system is capable of pumping up to 1850 gpm (in parallel operation) or 925 gpm (in series operation) and is used when a lightweight pumping system with an increased capacity or head pressure is required to dewater or counterflood compartments for ballast and stability.

Single Pump Configuration includes:

- 1 Power Unit, Hydraulic, Mod 10, Diesel, 30 gpm @ 3000 psi PW0030
- 1 Spare Parts Kit, for Power Unit PW0030, PW0031
- 1 Ancillary Set, for PU0208 Pump, Single Pump Configuration PU0209
- 1 Pump, Submersible, 4", Hydraulic PU0208
- 1 Reel, Hydraulic Hose Assembly HC0003

Double Pump Configuration includes:

- 1 Power Unit, Hydraulic, Mod 6, Diesel, 52 gpm @ 2500 psi PW0045
- 1 Spare Parts Kit, for Power Unit PW0045, PW0046
- 1 Ancillary Set, for PU0208 Pump, Double Pump Configuration PU0207
- 2 Pump, Submersible, 4", Hydraulic PU0208
- 1 Reel, Hydraulic Hose Assembly HC0003

C-2.4 6-Inch Submersible Pumping System, (ESSM System Number S18000). The 6-Inch Submersible Salvage Pumping System S18000 is a high-capacity pumping system used for dewatering, counterflooding, or other purposes requiring movement of water. The system consists of a 6-inch hydraulic submersible pump, hydraulic power unit, hose reel assembly, 120-gallon fuel storage tank, portable work station, tripod, spare parts kit, and ancillary set.

The system is NOT configured to pump petroleum products from a stranded vessel. See P17100 for this capability.

System includes:

- 1 Containment Pool, Machinery, 10' × 6' x 12", Cooley Urethane CP3010
- 1 Containment Pool, 6' × 4' × 12", Cooley Urethane CP3020
- 1 Pump, Salvage, Submersible, Hydraulic, 6" PU0295
- 1 Power Unit, Hydraulic, Mod 8, Diesel, 71 gpm @ 4000 psi PW0200
- 1 Hydraulic Hose Reel Assembly for PW0200, PW0201
- 1 Fuel Storage Tank, 120-Gallon PW0202
- 1 Ancillary Set (6" Submersible Salvage Pumping System) PW0203
- 1 Workstation (6" Submersible Salvage Pumping System) PW0204
- 1 Tripod (6" Submersible Salvage Pumping System) PW0205
- 1 Spare Parts Kit for Mod 8 HPU PW0200, PW0206
- 1 Roundsling Bridle, Polyester, 4-Leg, 6" SL0385

C-2.5 <u>6-Inch Submersible Pumping System, (ESSM System Number S18900)</u>. The 6-inch, Submersible Pumping System S18900 consists of a 6-inch, hydraulically driven, submersible pump, a control block, ancillary set, hydraulic power unit, hydraulic hose assembly and reels, and spare parts. It is a high capacity system used for dewatering, counter flooding, or any requirement requiring the transfer of water.

<u>System includes:</u>

- 2 Reel, hydraulic hose assembly HC0003
- 1 Pump, submersible, 6-inch, hydraulic PU0290
- 1 Ancillary set (for PU0290) PU0291
- 1 Hydraulic flow control block PU0292
- 1 Power unit, Mod 6, hydraulic, diesel PW0045
- 1 Spare parts kit (for PW0045) PW0046

C-2.6 <u>2½-Inch Jetting Pumping System, (ESSM System Number S18500)</u>. The 2½-inch Jetting Pump System S18500 consists of a skid-mounted, portable, diesel-powered pump; an ancillary set; and spare parts kit. The ancillary set includes 2½-inch diameter firehose, various fittings, a foot valve, and other items necessary for system operation. The system is mainly used for jetting, but also can be used for firefighting and limited dewatering.

<u>System includes:</u>

- 1 Pump, jetting
  - Pump, jetting, 500 gpm @ 150 psi, diesel (2nd gen) PU0228
  - Pump, jetting, 500 gpm @ 300 psi, diesel PU0229
  - Pump, jetting, 500 gpm @ 150 psi, diesel (1st gen) PU0230
- 1 Spare parts kit (for PU0230) PU0231
- 1 Ancillary set (for PU0229/PU0230) PU0232

C-2.7 <u>3-Inch Trash Pumping System, Diesel (ESSM System Number S18200)</u>. The 3-inch Diesel Trash Pumping System S18200 consists of a lightweight, diesel driven, centrifugal pump, a spare parts kit, and an ancillary set. The pump is capable of handling debris up to about 1½ inches in diameter. A protective cage assembly surrounds the engine and pump, providing protection during shipping, use, and storage. The unit can be carried by two personnel and can be also be handled by a forklift. The ancillary set consists of suction and discharge hoses, various fittings, clamps, nipples, and additional items necessary to support system operation. The 3-Inch Trash Pump can be used for dewatering, counter flooding, or any other application where water must be pumped.

<u>System includes:</u>

- 1 Pump Centrifugal, 3-Inch, Diesel, Trash PU0330
- 1 Spare Parts Kit for PU0330 Pump PU0331
- 1 Ancillary Set for 3-Inch Trash Pump PU0234 & PU0330 PU0235

C-2.8 <u>3-Inch Pumping System, Diesel (ESSM System Number S18100)</u>. The 350-gpm, 3-inch Diesel Pumping System S18100 consists of a portable, skid-mounted, diesel-driven, centrifugal pump; a spare parts kit; and an ancillary set. The pumping system is used for dewatering stranded ships, counter-flooding compartments, or other situations that require the pumping of water.

<u>System includes:</u>

- 1 Pump, centrifugal, 3-inch, diesel PU0201
- 1 Spare parts kit PU0202
- 1 Ancillary Set PU0203

C-2.9 <u>6-Inch Pumping System, Diesel (ESSM System Number S18300)</u>. The 1500 gpm, 6-inch Diesel Pumping System S18300 consists of a portable, diesel-driven, centrifugal pump, an ancillary set; and a spare parts kit. The ancillary set contains suction and discharge hoses, various hose fittings, a foot valve, and other items necessary for system operation. The pumping system is used for dewatering stranded ships, counter-flooding compartments for stability and trim, and other water pumping applications.

<u>System includes:</u>

- 1 Pump, centrifugal, 6-inch, diesel PU0210
- 1 Spare parts kit PU0211
- 1 Ancillary set PU0212

C-2.10 <u>10-Inch Pumping System, Diesel (ESSM System Number S18400)</u>. The 3000 gpm, 10-inch, Diesel Pumping System S18400 consists of a portable, diesel-driven, centrifugal pump, an ancillary set, and a spare parts kit. The ancillary set contains suction and discharge hose, various hose fittings, a foot-valve and other items necessary for system operation. The pumping system is used for dewatering stranded ships, counter-flooding compartments for stability and trim, and other water pumping applications.

<u>System includes:</u>

- 1 Pump, centrifugal, 10-inch, diesel PU0220
- 1 Spare parts kit (for PU0220 pump) PU0221
- 1 Ancillary set (for PU0220 pump) PU0224

C-3 <u>POLLUTION CATALOG</u>.

C-3.1 <u>6-Inch POL Submersible Pumping System (ESSM System Number P17100)</u>. The 6” Submersible Hydraulic Pumping System P17100 is packaged in several containers for ease of shipment and handling at the casualty site. The pump with attached hoses can be lowered into tanks through 12½-inches in diameter Butterworth or larger tank top access hatches, or can be hand carried into confined spaces. The pump is hydraulically driven by the standard ESSM Model 6 hydraulic power unit. Several pumping systems are required to support a major vessel casualty. For emergency offloading up to four pumps may be in operation at any one time discharging from individual tanks. Another two or three pumps may be needed to pump ballast water back into the tanks, or as backup standby pumps.

System includes:

- 1 Pump, Submersible, 6”, Hydraulic (POL) PU0280
- 1 Ancillary Set for PU0280 Pump PU0281
- 1 Hydraulic Flow Control Block for PU0280 Pump PU0282
- 2 Reel, Hydraulic Hose Assembly PU0283
- 1 Tripod (POL) PU0284
- 1 Power Unit, Mod 6, Hydraulic, Diesel, 52 gpm @ 2500 psi PW0045
- 1 Spare parts kit for power unit PW0045 PW0046
- 1 Winch, hydraulic, 5000-pound WN0280

C-3.2 2-Inch to 6-Inch Submersible Hydraulic Pumping System (ESSM System Number P17200). The 2-inch to 6-inch Submersible Hydraulic Pumping System P17200 is a versatile system designed to meet a wide range of on-scene pollution and salvage support requirements. The system is housed in the 2” to 6” Submersible Hydraulic Pump System Van, VA0280.

System includes:

- 1 Power Unit, Hydraulic, Mod 8 Diesel, 71 gpm @ 4000 psi (Poll) PW0200B
- 1 Fuel Storage Tank, 120-Gallon PW0202
- 1 Pump, Peristaltic, 2” Diesel PU0300
- 1 Ancillary Pallet 2” to 6” Hydraulic Submersible Pumps PU0832, including:
  - 1 Power Unit, Hydraulic, Mod 9, Diesel, 10 gpm @ 2000 psi PW0020
  - 1 Pump, Submersible, 2” Hydraulic PU0830
  - 1 Pump, Trash and Slurry, 2” Hydraulic PU0835
  - 1 Control Block for 2” Hydraulic Pumps PU0830 & PU0835
- 2 Pump, Diaphragm, 2”, Pneumatic PU2105
- 4 Pump, Submersible, 4” Hydraulic, Centrifugal Screw PU0305
- 1 Control Block for 4” Hydraulic Pump PU0305, Primary PU0306
- 1 Control Block for 4” Hydraulic Pump PU0305, Secondary PU0307
- 2 Pump, Submersible, 6”, Hydraulic, Pollution (High Capacity) PU0310
- 2 Control Block for 6” Hydraulic Pump PU0310, PU0311
- 2 Pump, Heavy Oil Transfer (DOP-250) PU0851
- 2 Pump, DOP-160 PU0840
- 2 Tripod (POL) PU0284
- 2 Winch, Hydraulic, 6000-Pound, Series 6 WN0281
- 1 Hot Tap Kit, Lightweight, Heavy Duty HT0007, including:
  - 2 Hot Tap, Lightweight, Heavy Duty HT0006
- 2 Drill, Hydraulic, ½” DR0010
- 1 Kit, Drill Press, Hydraulic, Underwater KT0050, including:
  - 1 Drill Press, Hydraulic, Underwater, ½” DR0011

C-3.3 Viscous Oil Transfer System (ESSM System Number P13200). The Viscous Oil Transfer System P13200 consists of a modified Archimedes’ screw-type pump and the necessary ancillary equipment for proper system operation. The system is designed to move highly viscous products at high discharge pressures from casualty vessels. It also aids in moving ballast water, offloading skimmer sumps, and in the recovery of viscous products that have escaped the stricken vessel. The system is packaged in one wire basket that also serves as a storage/shipping container.

System includes:

- 1 Pump, heavy oil transfer (DOP-250) PU0851

C-3.4 Steam Generator (ESSM System Number P12200). The Steam Generator System P12200 consists of two 60-hp steam generators, a 25-kW generator, a heating coil, an ancillary basket with all the necessary ancillary equipment, a water treatment skid package, a tool box, and a 20’ ISO shipping container. The two 60-hp steam generators can be operated independently or simultaneously. When operated simultaneously, they produce 120-hp steam. The steam generators and support equipment can all be removed from the shipping container and operated independently. Each component weighs less than 4000 pounds and is designed to be air lifted to a stricken vessel. Recovery and pumping operations often require the heating of highly viscous product. The SUPSALV skimmers have offloading pumps that can remove recovered product from the skimmer storage tanks in most cases. However, if the product is very viscous it must be heated to remove it. The pumping of very viscous product during lightering operations may also require the heating of the product. The steam generator system provides the steam heat required in cold weather operations for oil-water separation, for lightering vessels, and for cleaning of equipment used at a spill site.

System includes:

- 1 Van, Steam Generator System VA2500
- 1 Containment Pool, Machinery, 5’ × 5’ × 12” CP3000
- 1 Containment Pool, Machinery, 10’ × 6’ × 12” CP3010
- 1 Generator, 25-kW, Diesel, Model C14J25SQ GE0440
- 2 Generator, Steam, 60-hp, Model E-10 SG0010
- 1 Heating Coil, Submersible SG0011
- 1 Ancillary Basket for Steam Generator System P12200 SG0012
- 1 Water Treatment Skid Package, 120-hp Capacity SG0015
- 4 Roundsling, Polyester, 16’ SG0012
- 1 Tool Box, Steam Generator Van TL0085

C-3.5 Oil/Water Separation System (ESSM System Number P12100). The Oil/Water Separation System P12100 is a passive separator system that is designed to separate oil and solids from waste water. The waste water flows into the separator and contacts the coalescing plates which allows the oil and solids to separate from the waste water.

System includes:

- 1 Separator, oil/water, gravity plate, 100 gpm SR0815
- 1 Heater, external, oil/water separator SR0820

C-3.6 Hot Tap System (ESSM System Number P10100). The Hot Tap System P10100 consists of four hot tap machines (two Hot Tap Machines MC0110 and two Heavy Duty Lightweight Hot Taps HT0006), two Mod 2 hydraulic power units, two hydraulic hose reel assemblies, two stud guns, a hydraulic grinder, a hydraulic impact wrench, a Fluke 87 multimeter, two machinery containment pools, four 16’ Roundsling bridles, and one container van used for storing and shipping. The Hot Tap System is used underwater by divers to allow oil to be removed from sunken or distressed ships by installing a flange and valve on the side of the ship’s hull or tank through which oil can be discharged. This can be accomplished without spilling the oil or admitting water into the tank. When the equipment is in an operating configuration, the storage/shipping container serves as a maintenance shop and personnel shelter.

System includes:

- 1 Van, Hot Tap VA0736A or VA0736B
- 1 HVAC Unit w/Sleeve AC2001
- 1 Cord, Power Supply, 50’ CD0010
- 2 Containment Pool, Machinery, 10’ × 6’ 12”, Cooley Urethane CP3010
- 2 Drill, Hydraulic, ½-inch DR0010
- 2 Gun, Stud, Hot Tap Systems GU0120
- 2 Hose Reel Assembly, Hydraulic, w/¾” Synflex Hose HS0137
- 2 Hot Tap, Lightweight, Heavy Duty HT0006
- 2 Machine, Hot Tap MC0110
- 2 Power Unit, Hydraulic, Mod 2, Diesel, 15 gpm @ 2000 psi PW0108
- 1 Multimeter, RMS True, Fluke 87 SE0853
- 4 Roundsling, Polyester, 16’ SL0012
- 1 Grinder, Hydraulic TL1000
- 1 Wrench, Impact, Hydraulic TL1010

C-3.7 Annular Water Injection (AWI) Kit (ESSM Number KT0860).

The Annular Water Injection (AWI) Kit (KT0860) uses water to reduce the pressure that is created by high internal friction when a highly viscous oil product is pumped through a hose. Water is introduced into the discharge side of a positive-displacement lightering pump at a pressure greater than that of the discharged viscous product. This water mixes minimally with the discharged oil and forms a ring around the viscous product. The product, with the lubricating sleeve of water, is allowed to flow through the discharge hose at a much lower pressure and, as a result, at a higher flow rate.

Kit includes:

- 1 Cap, Pipe, 1¼”
- 1 Nipple, SS, 1” (Spare)
- 21 Bolt w/Nut, Washer, LK Wash, ¾-10 × 3½”
- 3 Bolt w/Nut, Washer, LK Wash, ¾-10 × 4”
- 8 Bolt w/Nut, Washer, LK Wash, ¾-10 × 6”
- 5 Bolt, Hex Head, ¾-10 × 4”
- 28 Nut, SS, ¾” UNC
- 20 Gasket, ANSI Flange, 6”, SO600
- 1 Gasket, Cam-Lok, 6”, NG60
- 17 O-Rings, 6”, B13887-60
- 1 Adapter X ANSI Discharge Flange, 6”, DWG 7022715
- 2 Adapter, Double Female, 6”, A-ADP-6FS-6FS
- 3 Adapter, Double Male, 6”, A-ADP-6MS-6MS
- 2 Adapter, Fem Cam-Lok X Male Hydrasearch, 6” A-ADP-6CGS-6MS
- 1 Adapter, Female Cam-Lok X Female NPT, 4”, 400-D/400
- 4 Adapter, Female Split Clamp X Flange, 6”, A-ADP-6FS-6F
- 4 Adapter, Flange, X Male Split Clamp, 6”, A-ADP-6F-6MS
- 2 Adapter, Male Cam-Lok X Fem Hydrasearch, 6”, A-ADP-6CMG-6FS
- 2 Ammo Box 1
- 1 Ammo Box 2 (Bolts)
- 1 Ammo Box 3 (Gaskets)
- 1 Annular Flange for PU0860, DWG 7022707
- 8 Clamp, Split, Hose Coupling, 6”, A-CLMP-6S
- 1 Control Stand, DWG 7022760
- 1 Desmi Adapter X ANSI Discharge Flange, 6”, DWG 7022717
- 3 Disc, Rupture, SS, 1½”, SPEC 210-PSIG
- 1 Elbow, Double ANSI Flange, 22½°, 6”, DWG 7022712
- 1 Elbow, Double ANSI Flange, 90°, 6”
- 1 Elbow, Long Radius, 90°, 6”, DWG 7022709
- 8 Hose w/Cam-Lok, Rubber 1½” × 25’
- 4 Hose w/Male & Fem Aeroquip QD’s, Hyd, -16, 25’, 2781-16
- 1 Hose, Semi-Rigid, 6” × 6’
- 2 Hose, 6” x 50’, Layflat w/M/F Cam-Lok Fittings, SS242
- 1 Instrumentation Set for PU0860, 540X165
- 1 Monitor and Test Piping for PU0860, DWG 7022711
- 2 Plug, Male Split Clamp, 6”, A-PLG-6MS
- 1 Pump, Water Injection, VOPS, CC41ERM-3U502-U16-45A-5J4
- 1 Strainer, RH520
- 1 Container w/Lid, Plastic, 70” × 48” × 50”, 705002/7048C0
- 15 Cap, Dust (Aeroquip)
- 1 Cap, Dust (Snap-Tite)

APPENDIX D
CHECK LISTS FOR EMERGENCY PETROLEUM TRANSFERS

D-1 INITIAL SURVEY INFORMATION.

Casualty Name: _________________________ Location: ____________________________

Date: ___________________ Ambient Temperature: _____^{o} (F / C)

1. CARGO

a. Attach or sketch the cargo tank arrangement.

b. Cargo details:

Tank	Cargo	Sp Gr	Quantity	Inerted (Y/N)	Comment

c. Tanks known or believed to be damaged:

Tank	Cargo	Quantity	Water Bottom Depth

d. Is all cargo pumpable at ambient temperatures? (Y/N) _______

2. LOAD COMPUTER

a. Does the ship have a load computer? (Y/N) ______

b. Where is it located? ____________________________

c. Operator? _______________________________________

d. Type? ____

e. Output:

Drafts ____________

Shear _____________

Bending _________________

Stability ________________

Grounded Condition Option? (Y/N) _______

3. TANK GAGING SYSTEM

a. Is an automatic tank gaging system installed? (Y/N) _______

b. Is it operable in all tanks? (Y/N) ________

If No, list tanks in which the system is not operable and note method of gaging.

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

4. CARGO PUMPS AND PIPING SYSTEMS

a. How many pumprooms are there? ______

b. List the pumps in each pumproom:

Pumproom	Pump	Type	Capacity	Operable (Y/N)

c. Is normal pumproom ventilation operable? (Y/N) ___________

If No, how will the pumproom be ventilated?

____

____

d. Are the pumproom bilges free of large accumulations of petroleum? (Y/N) ___________

If No, how will they be dried and kept dry free of petroleum accumulations?

____

____

e. Does the ship have a Piped, Free Flow, or Combination system?

f. What is the diameter of the piping mains? ________

g. Attach drawings or sketches of the piping system showing the tanks served by each main.

h. Are all valves operable and tight? (Y/N) _________

i. What limitations are placed on the system by leaking or inoperable valves?

____

____

j. What piping is known or suspected to be damaged?

____

____

k. Which tanks cannot be pumped because of damaged piping?

____

____

4. CARGO PUMPS AND PIPING SYSTEMS (continued)

l. Are all pumproom cross connections operable? (Y/N) _____

m. What limitations are placed on pumping by inoperable cross connections?

____

____

____

n. Are valves power-operated? (Y/N) ______

(1) If Yes, by what means Hydraulic, Pneumatic.

(2) Are power valve operators operable? (Y/N) ______

(3) Which valve operators are inoperable?

____

____

____

o. Can valves with inoperable power operators be operated manually (Y/N) ______

p. What limitations are placed on pumping by inoperable valves?

____

____

____

q. What is the distance from the center of the manifold to the Bow/Stern?___________

r. What are the number and size of valves on the manifold?

____

____

____

____

s. Are all manifold valves operable? (Y/N) _______

5. VENT SYSTEMS

a. Does the ship have an Open or Closed vent system?

If Open are all vents open and protected with proper safety devices? (Y/N) ______

b. Are all PV valves properly set and operable? (Y/N) ______

6. INERT GAS SYSTEMS

a. Is there an installed inert gas system? (Y/N) ______

b. Is it operable? (Y/N) ________

c. What is the pressure and oxygen content in each tank?

Tank	Pressure	Oxygen Content

Tank	Pressure	Oxygen Content

7. AUTOMATIC TRANSFER SYSTEM

a. Is there an automatic transfer system? (Y/N) ______

b. Is the automatic transfer system operable? (Y/N) _______

If No, can it be made operable? (Y/N) ______

8. MOORING SYSTEMS

a. Winches:

Type	Location	Brake Holding Power	Operable (Y/N)

b. Wire Ropes

Diameter	Breaking Strength	Length	Condition

c. Bitts and Chocks

Bitt/Chock	Size	Location	Condition

D-2 RECEIVING SHIP INSPECTION CHECK LIST.

This check list is designed to for a tanker that is to be the receiving vessel in an emergency transfer. If the receiving vessel is a barge, only applicable portions should be used.

1. SHIP INFORMATION

a. Ship's Name ____

b. Previous Names____

____

c. Particulars:

LOA	Beam	Full Summer Draft	Deadweight	Available Deadweight

d. Call sign __________

SATCOM number ___________

FAX number __________

e. Built at _____________________

Date Built ____________________

f. Nationality ____________________________

Port of Registry ___________________________

g. Owner ____

Manager ____

h. Classification Society _____________________

Is ship in Class? (Y/N) _________

If No, explain. ____

____

i. Ship's P and I Club __________

j. Ship's Insured Value ___________________

k. Master _____________________

(1) Master's Nationality _____________________

(2) Master's License ______________________________

(3) Does the Master speak and read English (Y/N) ________

1. SHIP INFORMATION (continued)

l. Does the ship have a full complement of officers and crew licensed or certificated in accordance with the requirements of the Flag State? (Y/N) ___________

If No, list exceptions.

____

____

(1) Officers' Nationality ______________________________

(2) Crew's Nationality ________________________________

(3) Shipboard language _______________________________

m. What is the experience of the Master, officers, and crew in ship-to-ship transfers?

____

____

n. Are the certificates listed below on board and valid?

(1) Loadline Certificate (Y/N) _______

(2) SOLAS Safety Equipment Certificate (Y/N) _______

(3) SOLAS Safety Construction Certificate (Y/N) ______

(4) Radio Safety Certificate (Y/N) _______

(5) International Oil Pollution Prevention (IOPP) Certificate (Y/N) _______

(6) USCG Financial Responsibility Certificate (Y/N) ______

(7) Civil liability Certificate (Y/N) _______

(8) TOVALOP Certificate (Y/N) ______

(9) Federal Maritime Commission Certificate (Y/N) _______

o. Does the vessel comply with all applicable Coast Guard regulations? (Y/N) ________

If No, list exceptions

____

____

p. Does the vessel comply with current SOLAS regulations? (Y/N) ________

If No, list exceptions

____

____

q. Are copies of the OCIMF/ICS publications International Safety Guide for Oil Tankers and Terminals and Ship to Ship Transfer Guide on board? (Y/N). _____

2. CARGO

a. Attach or sketch the cargo tank arrangement.

b. What was the last cargo? ___________________________________

c. Have the tanks been cleaned by any method since the last cargo was carried? (Y/N) _______

If Yes, what method? _________________

d. What is the nature of any residues on board?

____

e. Are the tanks suitable for the cargo that will be transferred to them? (Y/N) _____

If No, why not?

____

3. TANK GAGING SYSTEM

a. Is an automatic tank gaging system installed? (Y/N) _______

b Is it operable in all tanks? (Y/N) ________

If No, list tanks in which the system is not operable and note method of gaging.

____

4. CARGO PUMPS AND PIPING SYSTEMS

a. How many pumprooms are there? ______

b. List the pumps in each pumproom:

Pumproom	Pump	Type	Capacity	Operable (Y/N)

c. Is normal pumproom ventilation operable? (Y/N) ______

d. Are the pumproom bilges free of large accumulations of petroleum? (Y/N) ________

If No, how will they be dried and kept dry free of petroleum accumulations?

____

e. What is the distance from the center of the manifold to the Bow/Stern?____________
From the deck to the center of the manifold? _____________
From the rail to the center of the manifold? ______________

g. What is the number and size of valves on the manifold?

____

h. Are all manifold valves operable? (Y/N) _______

5. VENT SYSTEMS

a. Does the ship have an Open or Closed vent system?

If Open, are all vents open and protected with proper safety devices? (Y/N) ______

b. Are all PV valves properly set and operable? (Y/N) ______

6. INERT GAS SYSTEMS

a. Is there an installed inert gas system? (Y/N) ______

b. What is its capacity? ___________________

c. Is it fully operable? (Y/N) ________

7. FENDERING

a. Does the vessel carry her own fendering system? (Y/N) ______ If Yes:

Fender Type	Size	Location

Fender Type	Size	Location

b. Is the fendering system suitable for the proposed operation? (Y/N) _______________

If No, Why not?

____

____

____

____

c. Are the fenders properly rigged? (Y/N) ______

If No, what changes must be made in their rigging?

____

____

____

____

8. MOORING SYSTEMS

a. Winches:

Type	Location	Brake Holding Power	Operable (Y/N)

b. Wire Ropes

Diameter	Breaking Strength	Length	Condition

c. Bitts and Chocks

Bitt/Chock	Size	Location	Condition

9. COMMENT

____

____

____

____

____

10. SUMMARY

a. Is the vessel suitable for the proposed operations? (Y/N) ______

b. If No, can she be made suitable? (Y/N) _______

c. If Yes, what work is necessary?

____

____

d. Can the vessel be made suitable in the time available? (Y/N) _______

D-3 PETROLEUM CARGO EMERGENCY TRANSFER OPERATIONS.

The purpose of this check list is to establish:

1. The officers in charge and their responsibilities
2. That the best methods are employed for the safety of personnel and vessels
3. That all safety and operational procedures are in place prior to commencing transfer operations.

This list supplements but does not replace the detailed transfer plan addressed in Section 3-2 of this manual.

Date: ___________________________

Casualty: ____ (name)

Receiving Vessel: ____(name)

Location: ____

Has a copy of *U.S. Navy Ship Salvage Manual, Volume 2*, (*Emergency POL Offloading*) S0300-A6-MAN-020 been provided to the Casualty and the Receiving Ship. (Y/N) Casualty _______ Receiving ship _______

1. GENERAL

a. The On-Scene Commander is: ____

b. The salvage officer with overall responsibility for the operation is:

____

____

(1) On the casualty the principal assistants are:

____

____

(2) On the receiving vessel the principal assistants are:

____

____

c. The casualty is commanded by: Captain ____

d. The receiving vessel is under the command or control of ____

e. Have all hands in each vessel's crew and the salvage crew been briefed on the purpose and overall plan for the operation?

(Y/N) Casualty _______ Receiving ship ______ Salvage crew _______

f. Have radio communications been established? (Y/N) _______

On what frequencies/channels? ________________________

g. Have portable radio handsets been distributed and tested satisfactorily? (Y/N) ______

On what channel(s) _______________________

h. Has the cathodic protection system operation been checked? (Y/N) _______

1. GENERAL (continued)

i. Have appropriate local authorities been advised of the operation? _______

j. Have appropriate navigational warnings been broadcast? (Y/N) _______

k. Are navigational signals for the transfer ready? (Y/N) Casualty _______ Receiving vessel _______

l. Are emergency tow wires rigged with the eyes at the water's edge and a maximum of 10 feet free on deck? (Y/N)

Casualty _______ Receiving vessel _______

m. Have weather forecasts for the operation been obtained and arrangements made for updating during the operation?

(Y/N) _______

n. The amount of cargo to be transferred is _____________ (tons)/(cubic meters)/(barrels) (Strike Two).

o. The capacity of the receiving vessel is _____________ (tons)/(cubic meters)/(barrels) (Strike Two).

p. The limiting draft of the receiving vessel is __________ (feet)/(meters) (Strike One).

q. The maximum pumping rate of the casualty is ____________ (tons)/(cubic meters)/(barrels) (Strike Two) per hour.

r. The maximum receiving rate of the receiving vessel is _____________ (tons)/(cubic meters)/(barrels) (Strike Two) per hour.

s. The time estimated for the cargo transfer operation is _________ hours.

t. Will cargo transfer operations be conducted on a 24-hour per day basis? (Y/N) _______

u. Has provision been made for adequate watches with proper supervision and adequate crew rest? (Y/N) _______

v. Have all hands in each vessel's crew and the salvage crew been briefed that cargo operations may be stopped by the salvage officer, either Master, or any other responsible person in the event of:

	Casualty	Receiving Vessel	Salvage Crew
Pollution or spillage (Y/N)			
Thunderstorms (Y/N)			
Still Air (Y/N)			
Fire (Y/N)			
Tank overflow (Y/N)			
Burst Hose (Y/N)			
Man overcome by fumes (Y/N)			
Unexpected refloating (Y/N)			

w. Have all hands in each vessel's crew and the salvage crew been briefed that the signal for stopping cargo operations is a continuous blast on the whistle or siren combined with ringing of the General Alarm? (Y/N)

Casualty ________ Receiving vessel _______ Salvage crew _______

x. Are copies of the OCIMF/ICS publications International Safety Guide for Oil Tankers and Terminals and Ship to Ship Transfer Guide on board? (Y/N)

Casualty ________ Receiving vessel _______

2. FENDERING

a. The Casualty/Receiving Vessel (Strike One) will provide fenders.

b. Fenders:

(1) Primary fenders:

Type	Size	Location	Number/Size of Lowering Wires

(2) Secondary fenders:

Type	Size	Location	Number/Size of Lowering Wires

(3) Tertiary fenders:

Type	Size	Location	Number/Size of Lowering Wires

(4) Floating fenders

Type	Size	Location

c. Are hand-held fenders available forward and aft? (Y/N) Casualty ______ Receiving Vessel ________

3. MOORING

MOORING OPERATIONS SHOULD BE CONDUCTED ONLY DURING DAYLIGHT

a. The Casualty/Receiving Vessel (Strike One) will provide moorings.

b. Have all hands in each vessel's crew and the salvage crew been briefed on mooring methods? (Y/N)

Casualty _____ Receiving vessel _______ Salvage crew ______

c. Have the commanding officers/masters and salvage officer agreed to the method of approach, mooring methods, emergency procedures, and unmooring procedures? (Y/N)

Casualty _______ Receiving vessel ________ Salvage Officer _________

d. Ships are to lay Head to Head/Stern to Stern (Strike One)

with the ______________ side of the casualty to the ________________ side of the receiving ship.

e. Freeboard at mooring will be: Casualty _______ Receiving vessel ________ Difference: ___________

f. Access between ships is by _____________________ provided by:

Casualty _______ Receiving vessel ________

g. Have the Engineer Officers/Chief Engineers been briefed on engine requirements? (Y/N)

Casualty _______ Receiving vessel ________

h. Are both ships as nearly upright as possible? (Y/N)

Casualty _______ Receiving vessel ________

i. Mooring Lines:

Type	Size	Location	Tail (Y/N)

j. Have all constant tensioning winches been put in Manual? (Y/N) ________

3. MOORING (continued)

k. Are messengers, stoppers, and heaving lines in place and ready? (Y/N) Casualty ______ Receiving vessel _________

l. Are axes available at each mooring station? (Y/N) Casualty ______ Receiving vessel _________

m. Have all fenders and securing lines been checked? (Y/N) ______

n. Receiving ship will be moored by:

Commanding Officer/Master ______ Salvage Officer or Mooring Master ________ Pilot ________

o. Tug assistance available:

____

____

____

____

p. Salvage crew is to provide _______ hand mooring crew to the casualty.

Salvage crew is to provide _______ hand mooring crew to the receiving vessel.

q. Line handling boat is to be provided by ______________________________

r. Continuous mooring watch on the casualty is to be provided by:

Casualty _______ Salvage crew ________

Continuous mooring watch on the receiving vessel is to be provided by:

Receiving vessel _______ Salvage crew ________

s. Mooring operation is to begin at ___________(time) on _________

The state of the tide is ________________ current is _______________ slack water is at _____________

Minimum acceptable weather conditions are:

____

____

____

____

t. Are all scuppers plugged and sealed? (Y/N) Casualty ______ Receiving vessel _________

u. Have all protrusions on the berthing side been retracted? (Y/N) Casualty ______ Receiving vessel _________

v. Has area traffic been checked? (Y/N) _________

w. Are accommodation doors and ports closed? (Y/N) Casualty ______ Receiving vessel _________

x. Is the anchor on the side opposite the transfer ready for letting go? (Y/N) Casualty ______ Receiving vessel _________

4. FIRE

a .Are all pump room fans working on both ships? (Y/N) Casualty ______ Receiving vessel _________

If No, is suitable emergency ventilation rigged and operable? (Y/N) ______

If Yes, describe:____

____

____

b. Are fire pumps running and mains pressurized on both ships? (Y/N) Casualty ______ Receiving vessel _________

c. Have all deck firemains and fire stations have been checked and found operable. (Y/N)

Casualty ______ Receiving vessel _________

d. Emergency fire pumps are located:

On the casualty ____

On the receiving vessel ____

Are all suctions clear? ____

e. The International Fire Connection is located on the casualty at:

____

f. Are at least 4 fire hoses with at least 2 each spray/jet nozzles and 2 foam nozzles rigged near the manifold on each vessel?

(Y/N) Casualty ______ Receiving vessel _________

g. Number and type of portable extinguishers (preferably dry chemical) available near the manifold on each ship?

Casualty _____ (number) __________________ (type). Receiving vessel ________ (number) _________________ (type).

h. Location of breathing apparatus with spare charged cylinders available on deck.

Casualty __________________ Receiving vessel __________________

i. What firefighting equipment and facilities are on tugs or salvage ships that are standing by?

(1) Foam _____________ gallons/tons

(2) Monitors ___________(number) with foam capability _________ (number)

(3) Hoses _____________ (number)

(4) Foam lines __________ (number)

(5) CO_2 connections _________ (number)

j. Are attending tugs and salvage crafts' fire mains compatible with the casualty's and receiving vessel's so they can be cross connected? (Y/N)

Casualty ______ Receiving vessel _________

k. In the event of fire the salvage vessel/tug ________________________ (name) will attend the casualty.

The salvage ship/tug ________________________ will attend the receiving vessel.

4. FIRE (continued)

l. Is the inert gas system on the casualty operable? (Y/N) _______ List tanks NOT inerted below 8% oxygen:

____

____

m. Is the inert gas system on the receiving ship operable? (Y/N) ________ List tanks NOT inerted below 8% oxygen:

____

____

n. Are tanks not inerted gas free or ballasted to 99%? (Y/N) ________

o. Is a salvage inert gas generator on board? (Y/N) _______

Where is it located? ________________________ What is its capacity? ________________________

5. POLLUTION

a. The local agency with spill control responsibility is: __________________________

b. The responsible officer is ____

c. What spill response equipment is on scene and ready for use?

(1) Aboard the casualty ____

____

(2) Aboard the receiving vessel ____

____

(3) Aboard salvage ships, tugs, or pollution response craft? ____

____

d. Is the site boomed? (Y/N)? ____

If Yes, what type and length boom:____

If No, is boom available in the area or on site?(Y/N) ______ If Yes, what type and length boom:

____

e. Units tasked to deal with pollution:

(1) Between the ships: ____

(2) Escaped oil: ____

f. Is it possible the ship may rise to uncover bottom or side damage? (Y/N) ______ If Yes:

(1) How much pollution is expected? ______________________________________

(2) What unit(s) will respond to the pollution? ____

____

6. MACHINERY AND ELECTRICAL SYSTEMS

a. Is all electronic equipment except VHF radios off and grounded? (Y/N)

Casualty ______ Receiving vessel _________

b. Is all portable electrical equipment including hand-held radios and flashlights intrinsically safe? (Y/N)

Casualty ______ Receiving vessel _________

c. Are all fixed central air conditioning units on Recirculate? (Y/N)

Casualty ______ Receiving vessel _________

d. Are all window-type air conditioners disconnected? (Y/N)

Casualty ______ Receiving vessel _________

e. Is the galley an air conditioned electric galley? (Y/N)

Casualty ______ Receiving vessel _________

If No, is it shut down? (Y/N)

Casualty ______ Receiving vessel _________

f. Are all pantry and other cooking appliances isolated? (Y/N)

Casualty ______ Receiving vessel _________

g. Are all unsafe electrical circuits isolated at the main switchboard? (Y/N)

Casualty ______ Receiving vessel _________

h. Have engine room watches for the transfer been designated and procedures established? (Y/N)

Casualty ______ Receiving vessel _________

i. What machinery is inoperable?

(1) Casualty: ____

____

____

(2) Receiving Vessel: ____

____

____

j. Have engineer officers/chief engineers been briefed that tubes are not to be blown and that spark control and smoke emission are to be enforced while the ships are alongside? (Y/N)

Casualty ______ Receiving vessel _________

7. CARGO MANIFOLDS AND HOSES

a. Is the cargo manifold 10 feet or less from midships? (Y/N) Casualty ______ Receiving vessel _________

b. Is the center of the cargo manifold at least 3 feet and not more than 6=10" above the deck or the working platform? (Y/N)

Casualty ______ Receiving vessel _________

c. Does the ship have two 8-inch (400mm) manifold connections? (Y/N) Casualty ______ Receiving vessel _________

If No, what connections are available?

Casualty___________________________ Receiving vessel _________________________

d. Are all manifold connections ready and marked? (Y/N) Casualty ______ Receiving vessel _________

e. Are all drip pans in place? (Y/N) Casualty ______ Receiving vessel _________

f. Are sawdust and sorbents in place near the manifolds? (Y/N) Casualty ______ Receiving vessel _________

g. Are all tools required for Connection, Standby, Draining, and Disconnect available? (Y/N)

Casualty ______ Receiving vessel _________

h. Are all manifold connections that are not to be used closed and blanked? (Y/N) _______

i. Cargo hoses will be provided by: Casualty ______ Receiving vessel _________ Salvors ________

j. Hoses offered by the casualty or receiving vessel have been inspected (Y/N) ______ and found satisfactory (Y/N) ________

k. Hose information: Number ________ Diameter _______ inches Length ________ feet

Minimum bend radius _________ feet (Minimum bend radius in inches = 6 × Nominal Hose Bore in inches)

l. Hoses on the casualty will be connected and disconnected by: Ship's crew _______ Salvage crew _______

m. Hoses on the receiving ship will be connected and disconnected by: Ship's crew _______ Salvage crew _______

n. Hoses will be tended by: Ships' crews _______ Salvage crew _______

o. Derricks required:

(1) Casualty: Side (P/S) _______ SWL _________ tons.

(2) Receiving Vessel: Side (P/S) _______ SWL _________ tons.

p. Is the hose properly supported on the (Y/N) Casualty _____? Receiving vessel ________?

q. Hose flanges are Bonded/Insulated. (Strike One) If Bonded, bonding done by _______________________________

r. Are all hoses made up with new gaskets and do they have couplings that are either Locked/Pinned/Lashed (Strike Two)?

(Y/N) ________

s. Are all the hose saddle support lines off winches and stopped off to a suitable fitting? (Y/N) ________

t. Have hoses been tested? (Y/N) ________

8. CARGO OPERATIONS

a. Is the gangway in position and secured? (Y/N) _______

b. Are the proper navigation systems being shown? (Y/N) _______

Is the red loading light On? (Y/N) _______

c. Have all communications been checked and found satisfactory? (Y/N) _______

d. Is the following safety equipment on board?

(1) Explosiometer: (Y/N) _____ Location ___________________

(2) Oxygen Analyzer: (Y/N) ______ Location ____________________

(3) Multi-gas Detector: (Y/N) ______ Location ____________________

(4) Anemometer: (Y/N) ______ Location ____________________

(5) Interface Detector: (Y/N) ______ Location ____________________

(6) Linen Ullage Tapes: (Y/N) ______ Location ____________________

(7) Dispersant: (Y/N) ______ Location ____________________

(8) Loud Hailer: (Y/N) ______ Location ____________________

(9) Protective Clothing: (Y/N) ______ Location ____________________

(10) Resuscitator: (Y/N) ______ Location ____________________

(11) Rescue Stretcher: (Y/N) ______ Location ____________________

e. Have proper watches been set:

(1) Casualty:

(a) Bridge: (Y/N) _______

(b) Engine room (Y/N) _______

(c) On deck (Y/N) _______

(2) Receiving vessel:

(a) Bridge: (Y/N) _______

(b) Engine room (Y/N) _______

(c) On deck (Y/N) _______

(3) Salvage vessels: (Y/N) _______

(4) Salvage crew: (Y/N) _______

f. Is smoking restricted to one or two spaces or banned completely? (Y/N)

Casualty ______ Receiving vessel _________

Smoking MUST be banned completely if the casualty is holed or leaking or in an emergency.

8. CARGO OPERATIONS (continued)

g. Are cargo gas lines on the casualty on by-pass/set (Strike One) for an inert gas pressure of ______?

h. Are cargo gas lines on the receiving vessel on by-pass/set (Strike One) for an inert gas pressure of ______?

i. Are PV valves on the casualty in operating position/locked open? (Strike One)

j. Are PV valves on the receiving vessel in operating position/locked open? (Strike One)

k. Are inert gas systems operating? (Y/N) Casualty ______ Receiving vessel _________ Salvage _________

(1) On the casualty:

Feeding tanks _____________________________ at ______________ (capacity)

and ____________ (pressure).

Is capacity enough for the expected pumping rate? (Y/N) ________

(2) On the receiving vessel:

Feeding tanks ______________________________ at _____________ (capacity)

and ____________ (pressure).

Is capacity consistent with the expected receiving rate? (Y/N) ________

l. Have cargo calculations and bending moment and shear force calculations been done to the satisfaction of the salvage officer?

(Y/N) _______

m. Tanks on the casualty are to be gaged by automatic gaging system/ullages/innages (Strike Two),

taken and recorded at __________ intervals (should NOT EXCEED half hourly) by: Ship's crew _______ Salvors _______

n. Tanks on the receiving vessel are to be gaged by automatic gaging system/ullages/innages (Strike Two)

taken and recorded at __________ intervals (should NOT EXCEED half hourly) by: Ship's crew _______ Salvors _______

METALLIC ULLAGE TAPES ARE PROHIBITED IF THE CARGO IS A STATIC ACCUMULATOR

o. Are ullage ports free and shut? (Y/N) Casualty ______ Receiving vessel _________

p. Has a cargo sampling procedure been established? (Y/N) _______

q. Tugs standing by are ____

r. Are all sea valves closed and lashed? (Y/N) Casualty ______ Receiving vessel _________

s. Attach a copy of the casualty's offloading plan. _______

t. Attach a copy of the receiving vessel's loading plan. _______

9. OPERATIONS WITH SALVAGE PUMPS

a. Hydraulic/Electric (Strike One) salvage pumps are to be used to transfer cargo

from tanks____

to tanks ____

in Casualty/Receiving Vessel (Strike One or Both) or to the Salvage Deck Manifold located at _________________________

b. _______ (number) Hydraulic/Electric (Strike One)

______________________ (type or designation) will be used.

c. Are the pumps properly certified for the service they will perform? (Y/N) ______

d. The pumps are located at ____

e. Are the following accessories on board and located with the pumps?

(1) Power supply (and return) lines. (Y/N) ______

(2) Discharge hose. _______ (number) lengths (Y/N) ______

(3) Hose guide and rubber mat. (Y/N) ______

(4) Tripod and handling gear. (Y/N) ______

(5) Static ground strap. (Y/N) ______

(6) Gas escape prevention collar. (Y/N) ______

f. Are all discharge fittings made up and checked tight? (Y/N) ______

g. ELECTRIC PUMPS ONLY:

(1) Is the power supply intrinsically safe? (Y/N) _______

(2) Are all connectors an approved sealed type? (Y/N) _______

(3) There is a Fuse/Circuit Breaker (Strike One) set at ________ amps and located at __________________________

(4) Are all pumps properly grounded or bonded (Strike One)? (Y/N) _______

(5) Where is the pump control panel located? _________________

(6) Is the control panel fitted with voltmeters and ammeters for each pump? (Y/N) _______

h. The pump watches are ____ (Name(s))

i. Power for the pumps will be supplied by _______ (number) _______________________________________ (type)

Hydraulic Power Supplies/Generators located at ______________________________

j. The power supplies are located in an area that should remain free of fume accumulation. (Y/N) ________

k. The power supplies are fueled for ______ hours operation.

l. Additional fuel is located at ___________

m. Power supply watch ____ (name(s))

n. Pumps tested satisfactorily at __________ (time) _________ (date).

10. UNMOORING

UNMOORING OPERATIONS ARE TO BE CONDUCTED ONLY DURING DAYLIGHT

a. Do the commanding officers/masters and salvage officer agree on the method of letting go and disengaging? (Y/N)

Casualty ________ Receiving vessel _________ Salvage Officer __________

b. Have all cargo hoses been unrigged? (Y/N)

Casualty ________ Receiving vessel _________

c. Are hoses or manifolds blanked? (Y/N)

Casualty ________ Receiving vessel _________

d. Are gangways clear? (Y/N)

Casualty ________ Receiving vessel _________

e. Is the transfer side clear of all obstructions? (Y/N)

Casualty ________ Receiving vessel _________

f. Have fenders, towing lines and securing lines been checked? (Y/N)

Casualty ________ Receiving vessel _________

g. Is power on to the winches and windlass? (Y/N)

Casualty ________ Receiving vessel _________

h. Are messengers and stoppers in place and ready? (Y/N)

Casualty ______ Receiving vessel _________

i. Are axes available at each mooring station? (Y/N)

Casualty ______ Receiving vessel _________

j. Has the amount of cargo transferred been agreed to? (Y/N)

Casualty ________ Receiving vessel _________

k. Tug assistance available:

____

____

____

____

____

____

____

____

10. UNMOORING (continued)

l. Salvage crew is to provide _______ hand mooring crew to the casualty.

Salvage crew is to provide _______ hand mooring crew to the receiving vessel.

m. Does the receiving vessel require pilotage? (Y/N) _______

If Yes, who will provide? _________________________________

Is the pilot on board? (Y/N) _______

n. Upon unmooring the receiving vessel is to

____

____

____

____

____

____

____

____

o. Are all stations manned and ready? (Y/N)

Casualty ________ Receiving vessel _________

p. Have communications with all stations been established? (Y/N)

Casualty ________ Receiving vessel _________

r. Has traffic been checked? (Y/N) _______

s. Have appropriate local authorities been advised the transfer is complete? (Y/N) _______

t. Have navigational warnings been canceled? (Y/N) _______

GLOSSARY

A

Administration – The government of the state whose flag the ship in entitled to fly.

Aft, After - Toward the stern or the back of the vessel. Between the stern and the midship section of the vessel.

Afterbody - The section of the vessel aft of amidships.

Aframax - A tanker of such size as to take commercial advantage under Worldscale (generally, tankers 80,000-119,000 DWT).

Air Draft - The distance from the vessel's water line to the upper most point on the vessel, usually the top of a mast or radar tower. When a vessel has to transit areas where there may be overhead obstructions (bridges, power lines, cranes, loading arms, etc.) it is vital to know what its air draft (draught) will be at the time of transit. The air draft of a vessel will vary depending upon the draft of the vessel and its trim.

Aloft - Above the deck.

American Bureau of Shipping (ABS) - A Classification Society. Under the provisions of the U.S. Load-Line Acts - it has the authority to assign load lines to vessels registered in the U.S. and other countries.

Amidships (or 'Midships') - The middle portion of a vessel.

API - The American Petroleum Institute, founded in 1919, was the first oil trade association to include all branches of the petroleum industry.

API Gravity (Relative Density) - A means used by the petroleum industry to express the density of petroleum liquids. API gravity is measured by a hydrometer instrument having a scale graduated in degrees API.

B

Ballast - Seawater taken into a vessel's tanks in order to submerge the vessel to proper trim. Ballast can be taken into cargo tanks, double bottoms, fore and aft peak tanks and/or segregated ballast tanks, (SBT).

Clean - Term applied to the seawater used for ballast when it is not contaminated by any oil and is carried in clean tanks.

Dirty - Term applied to the sea water used for ballast when it is contaminated with the remnants or residue left in cargo tanks that previously carried crude oil or heavy persistent refined oils.

Permanent - Ballast carried in ship's tanks that were designed to carry nothing else.

Segregated/Dedicated - Ballast kept in tanks segregated from cargo pipes and tanks.

Ballast Movement - A voyage or voyage leg made without any paying cargo in a vessel's tanks. To maintain proper stability, trim, or draft, seawater is usually carried during such movements.

Ballast Passage - The "ballast leg" of a voyage as differentiated from the "loaded leg."

Ballast Pump- A pump used for filling and emptying the ballast tank.

Ballast Tanks - The tanks used to carry the vessel's ballast. They may be permanent, dedicated, or cargo tanks.

Barge - Also lighter. A general name given to a flat-bottomed craft specially adopted for the transportation of bulk cargoes.

Barrel - The standard unit of liquid volume in the petroleum industry. It is equal to 42 U.S. gallons.

Beam - The width of a ship. Also called its breadth.

Berth - Dockage space for vessel. Sleeping quarters. Also slang for having a crew position on the vessel

Bilge - The lower internal part of the hull where the vertical sides meet the bottom. This term applies to both the inside and the outside of the hull. The internal space can be the lower part of a ship's hold or the engine room and serves as a drainage area where accumulated water can run into and be pumped from.

Bill of Lading - A B/L is the basic document between a shipper and a carrier and a shipper and consignee. It represents the contract of carriage and defines the terms and conditions of carriage. It is the final receipt from the carrier for the goods shown on it and for the condition of the goods. It describes the nature, quantity and weight of the cargo carried. It is also the document of title of the goods shown.

Boilers - Steam generating units used aboard ship to provide steam for propulsion or for heating and other auxiliary purposes.

Boiler Room - Compartment in which the ship's boilers are located.

Boom - A general name given to a projecting spar or pole that provides an outreach for handling cargo.

Breadth - See Beam

Bridge AFT - Vessels with no midship house. All quarters with Bridge are contained in one superstructure at after end of vessel.

Bulbous Bow - A large protruding bow section designed to break water friction allowing the vessel to make better speeds.

Bulk Cargo - Usually a homogeneous cargo stowed in bulk, and not enclosed in any container.

Bunkers - Fuel for a vessel. The type will vary depending upon the propulsion mode of the vessel. Steamships will use a heavy fuel oil, diesels use a range of fuels from heavy to light, and gas turbines generally use kerosene.

Butterworth Tank Cleaning System - A mechanical device used for the purpose of cleaning oil tanks by means of high pressure jets of hot water. The apparatus basically consists of double opposed nozzles which rotate slowly about their horizontal and vertical axis and project two streams of water through all possible angles against all inside surfaces of the space being cleaned. The tank washing machines can deliver sprays of water at various temperatures and pressures that are dictated by the type of cargoes carried and the reasons for cleaning (Quick bottom wash through gas-freeing and tank entry for hot work).

C

Call Letters – The letters assigned to the ship's radio (station).

Camber - The arching of the deck upward measured at the centerline in inches per foot beam.

Capacity Plan - A general plan or inboard profile which gives all data relating to the capacity of cargo spaces, tanks, bunkers and storerooms.

Cargo Hose - A hose usually of 6 to 10 inches in diameter used for the transfer of cargo from ship to shore and vice versa.

Cargo Plan - A plan giving the quantities and description of the various grades carried in the ship's cargo tanks.

Cargo Pump - Pump used on tankers for discharging cargo and loading or discharging ballast. Located, at the bottom of the pump room, these pumps are usually of the common duplex type, or turbine type of which the centrifugal is the most common.

Catwalk - A raised bridge running fore and aft from the Midship House, and also called "walkway." It affords safe passage over the pipelines and other deck obstructions.

Centerline - A horizontal fore-and-aft reference line for athwartship ship measurements, dividing the vessel into two symmetrical halves.

Center Tanks - Cargo tanks located on the vessel's centerline.

Centrifugal Pump - A pump consisting of a shaft to which vanes are attached and which rotates in a circular casing. Water or liquid flows into the casing near the center of the rotating shaft and is propelled outward along the vanes by centrifugal force. It escapes through a discharge pipe at the circumference of the casing.

Charterer - The company or person given the use of the vessel for the transportation of cargo or passengers for a specified time.

Classification of Petroleum - Classes "A-C" of petroleum are considered flammable and have a flash point of 80° F or below. Examples of these classes range from very light napthas (Class A) to most crude oils (Class C). Class D cargoes such as kerosene and heavy crudes are considered combustible and have a flash point above 80° F but below 150° F. Class E cargoes are the heavier fuel oils and lubricating oils and have a flash point above 150° F.

Classification Society - The professional organizations which class and certify the strength and seaworthiness of vessel construction. Class and certification issued to each vessel may be required for insurance purposes. American Bureau of Shipping (ABS) and Lloyds Register of Shipping are two of the most well known classification societies in the world today.

Clean Service - Tanker transportation of products lighter than residual fuels, e.g. distillates, including No. 2 Heating Oil.

Clean Ship - Refers to tankers that have their cargo tanks free of traces of dark persistent oils that remain after carrying crudes and heavy fuels oils.

Clingage - The residue that adheres to the inside surface of a container, such as a ship's tank or shore tank, after it has been emptied.

Closed Gauging System - A method of obtaining measurements of the tank contents without opening the tank. This may be accomplished by using automatic tank gauges or by taking measurements through a pressure/vapor lock standpipe. This type of gauging is done extensively on vessels with inert gas systems. Such a system that allows no vapors to be lost to the atmosphere is a true closed system while other types that allow minimum vapors to be lost to the atmosphere are called "restricted systems."

Cofferdam - The narrow, empty space between two adjacent watertight or oiltight compartments. This space is designed to isolate the two compartments from each other and/or provide additional buoyancy. It prevents any liquid contents of one compartment from entering the other in the event of a bulkhead failure. In oil tankers, cargo spaces are usually isolated from the rest of the ship by cofferdams fitted at both ends of the tank body.

Coiled Ship - Refers to a tanker that is equipped with heating coils in the cargo tanks to permit the heating of cargo if necessary.

Consignee - The person to whom cargo is consigned as stated on the bills of lading.

Consignor - The shipper of the cargo.

Contamination - The result from commingling of a grade of cargo with a sufficient quantity of another grade to destroy the characteristics of the cargo.

Contract of Affreightment, (COA) - A service contract under which a Ship owner agrees to transport a specified quantity of fuel products or specialty products, at a specified rate per ton, between designated loading and discharging ports. This type of contract differs from a spot or consecutive voyage charter in that no specific vessel is specified. (Rates are usually discounted below other forms of contracts.)

Controlled Fleet - All ships owned and period chartered by affiliate(s).

Crude Oil Wash (COW) - A method of cleaning tanks using oil from the ship's cargo. COW is normally used when a tanker is discharging. Oil is taken from the tanks and pumped through a special line to fixed or semi-fixed tank washing machines where it is sprayed against all inside surfaces of the tank. This procedure removes any cargo which is 'clinging' to the surfaces of the tank.

Cubic Capacity - The inside measurement of a tanker's cargo compartments or tanks, usually expressed in barrels or cubic feet/meters.

Cubic Limitation - Reaching cargo tank capacity before vessel sinks to its load-line. This is usually caused by loading a light crude (crude with a high API) or clean products.

Custom of the Trade - A phrase sometimes used to describe an action or procedure that is not committed to writing, but which has been followed for a long time, and is considered 'standard practice' by practitioners in the trade.

D

Davits - A set of arms on a ship from which its lifeboats are suspended.

Deadfreight - Non-utilization of cargo carrying capacity on a vessel.

Deadweight – Deadweight Tonnage (DWT) - The lifting or carrying capacity of a ship when fully loaded. This measure is expressed in long tons when the ship is in salt water and loaded to her marks. When loaded to her summer marks the value is for her summer deadweight (SWDT). It includes cargo, bunkers, water, (potable, boiler, ballast), stores, passengers and crew.

Deadweight Scale - A table that is part of the vessel plans and indicates the draft the vessel will be down to at any particular phase of loading.

Deep Water Route - A designated area within definite limits which has been accurately surveyed for clearance of sea bottom and submerged obstacles to a minimum indicated depth of water.

Dirty Ballast - Applies to the seawater used for ballast when it is contaminated with the remnants or residue left in cargo tanks that previously carried crude persistent refined oils.

Dirty Service - Tanker transportation of crudes and residual fuels.

Dirty Ship - Refers to tankers that have been carrying crude oil and heavy persistent oils such as fuel oil and dirty diesel oils.

Displacement Tonnage - Expressed in tons it is the weight the water displaced by the vessel which in turn is the weight of the vessel at that time. The vessel's light displacement is the weight of the vessel only and the vessel's loaded displacement is the weight of the vessel and all cargo, stores, fuel, water, etc. on board.

Disponent Owner - Charterer who has sublet the vessel and is acting as the owner per the terms of the contract.

Double Bottom - A general term used for all watertight spaces contained between the outside bottom plating, the tank top and the margin plate. Double bottoms are usually sub-divided into a number of separate tanks and can be used to hold clean ballast, potable or boiler feed water, or fuel. They also provide a measure of protection for cargo tanks if bottom plating is damaged in the event of grounding. Chances of pollution may be diminished due to this protection.

Draft - The depth of a ship in the water. This distance is measured from the bottom of the ship to the surface of the water. Draft marks are cut into or welded on the surface of a ship's plating. They are placed forward and aft on both sides of the hull and also amidships. At the midships draft we will also find the authorized Load Line markings which designate maximum drafts allowed for vessels under various conditions.

Dry Certificate - A document issued at the discharge port by a representative of the consignee indicating that each shipboard cargo tank has been completely discharged.

Dry-dock - An enclosed basin into which a ship is taken for underwater cleaning and repairing. It is fitted with water tight entrance gates which when closed permit the dock to be pumped dry. Also called gracing dock, gracing dry dock.

E

Enrollment (U.S.) - The document issued by the U.S. Government to vessels under U.S. flag engaged solely in domestic coastwise trade, as distinguished from the Register, which is confined to vessels engaging in foreign trade.

Even Keel - The existing conditions of a vessel whose fore and aft drafts are equal.

F

Filling Density - The ratio of the weight of liquid in a tank to the weight of distilled water at 60° F. the tank will hold. It is expressed as a percent.

Flag State – Any state that allows ships to be registered under its laws.

Flags of Necessity (or Convenience) - Flag states that provide lesser economic, financial, tax and/or regulatory burdens to ship owners registering their ships in those countries.

Flame Screen (or Arrester) - A device comprised of a fine wire gauze that is fitted into the discharge end of a vent line. It prevents the passage of flame, but will allow vapor to pass through. Flame screens are also fitted to removable ullage plugs used to cover ullage holes on cargo tank tops.

Fleet Coordinators - Vessel dispatchers who coordinate vessel movements, bunkers, cargo, etc.

Force Majeure - Clause permitting contract to be broken in the event of uncontrollable events, e.g. war, strike government action, which preclude its fulfillment.

Fore, Foreward - Toward the stem or the bow. The section of the vessel between the stem and amidships.

Forepeak - The narrow extremity of the vessel's bow. Also the tank located in that part of the ship.

Frames - The ribs of a ship.

Free Discharge (FD) - The charterer is responsible for the cost of unloading the cargo.

Free In And Out (FIO) - The charterer is responsible for both the costs of loading and unloading the cargo.

Free on Board (FOB) - The charterer is responsible for the cost of loading the cargo.

Freeboard - The distance from the water line to the top of the weather deck on the side.

Fuel Oil - A name given to the heaviest grades of residual fuel used in marine oil burning boilers.

G

Gas Free - An atmospheric condition in a tank when it is free from any concentration of inflammable, noxious or toxic gases and vapors.

Gas Free Certificate - A certificate issued by a chemist after sampling the air in a tanker's cargo tanks after the cargo has been pumped out. It is endorsed with one of the following notations: (1) Safe for men, (2) Not safe for fire, (3) Safe for men and fire, (4) Not safe.

Gauging - Measuring depths, usually by means of a steel tape.

General Arrangement Plan - A drawing of a ship which lists all necessary statistics and operating information such as LOA, SDWT, cargo, water, fuel capacity, etc. The deadweight scale is also contained on this important chart which is usually posted outside the ship's office or mate's cabin.

Gross Tonnage - The internal capacity of a vessel measured in units of 100 cubic feet.

H

Handy Size - Tankers of about 12,000 to 25,000 DWT.

Heating Coils - Coils located in the bottom of cargo tanks that steam passes through to heat cargo. The heat lowers the viscosity of the cargo and permits easier pumping of the cargo at the discharge port. Vessels in clean service normally do not have or need heater coils as the viscosity of the clean products (with the exception of some lube oils) is high enough to permit easy pumping at atmospheric temperatures.

Hog (Hogging) - The condition of a vessel caused by the unequal distribution of cargo. When a vessel loads too heavily at the ends it causes an arching, or bending upward, of the hull at the midships area. This can also be caused by the vessel working in heavy seas with a large wave under the amidships section.

Hull - The body of the vessel not including its masting, rigging etc.

I

IMO – International Maritime Organization

In Class – A vessel currently meeting all the requirements of its Classification Society is "in-class".

Independent Inspector (Cargo Surveyor) - A person or organization of persons acting independently, but on behalf of, one or more parties involved in the transfer, storage, inventory or analysis of a commodity for purposes of determining the quantity, and/or quality of a commodity. They may also be assigned to the calibration of various measurement instruments and/or storage tanks ashore or on vessels.

Inert Gas (IG) - A gas used by marine tank vessels to displace air in cargo tanks to reduce oxygen content to 8 percent or less by volume and thus reduce possibility of fire or explosion. The inert gas used is usually nitrogen, carbon dioxide or a mixture of gases such as flue gas.

Inert Gas System (IGS) - A mechanical method of introducing inert gas into a vessel's tanks. An inert gas is one which has little or no ability to react with other gases, or to heat. Examples of inert gases are nitrogen and CO2. Shipboard inert gas systems utilize CO2, either from flue gas sources or from inert gas generators.

Inerting - A procedure used to reduce the oxygen content of a vessel's cargo spaces to 8 percent or less by volume by introducing an "inert" gas blanket such as nitrogen or carbon dioxide or a mixture of gases such as flue gas.

Innage - The amount of space within a tank that is occupied by oil. Innages are sometimes called soundings or body gauges.

Inshore Traffic Zone - A designed area between the landward boundary of a traffic separation scheme and the adjacent coast intended for coastal traffic.

Intake Certificate - A document issued by the shipper indicating the amount of cargo loaded aboard the vessel as calculated from the shore tank gauges. Freight is paid on the basis of these figures.

Intermediate Fuels - Light, residual-type fuel oils with characteristics between bunker fuel and marine diesel fuel, typically used in motor ships. It is quoted in terms of Redwood per second.

International Loadline Certificate - A document issued by a classification society stating the minimum freeboard granted to a vessel and giving the position of the loading disc on the ship's side.

Intertanko – International association of independent tanker owners.

ISGOTT – International Safety Guide for Tankers and Terminals

J

Jettison - The act of throwing goods or pumping cargo overboard to lighten a ship to improve stability in an emergency.

K

Keel - The backbone of the ship. It is a longitudinal beam or plate in the extreme bottom of a ship from which the ribs or floors start.

L

Length Between Perpendiculars (LBP) - The length of the vessel measured between the forward part of the stem to the after part of the rudder post.

Letter of Protest or Notice of Apparent Discrepancy - A letter issued by any participant in a custody transfer citing any condition with which issue is taken. This serves as a written record that the particular action or finding was questioned at the time of occurrence.

Length Overall (LOA) - The extreme length of the vessel measured from the foremost part to the aftermost part of the hull.

Lighter - **1)** General name for a broad, flat-bottomed boat used in transporting cargo between a vessel and the shore. The distinction between a lighter and a barge is more in the manner of use than in equipment. The term "lighter" refers to a short haul, generally in connection with loading and unloading operations of vessels in harbor while the term "barge" is more often used when the cargo is being carried to its destination or over a long distance. **2)** To load or discharge cargo to or from another vessel. VTBL vessel to be lightered.

Lighterage - **1)** Fee charged for conveying cargo by lighters or barges. **2)** Area where vessels normally lighter.
Lightering - Conveying cargo with another vessel known as a lighter from a ship to shore, or voyage.

Limited Liability - The law that permits a shipowner to restrict his liability to the value of this vessel after the accident plus the earnings for the voyage.

Limber Holes - Holes in the bottoms of stringers through which cargo flows through to the suction strums.

List - The leaning of the vessel to the port or starboard.

Lloyd's Register of Shipping - British classification society.

Load Displacement - The displacement of a vessel when it floats at its loading draft.

Load Line - The maximum draft to which the vessel may load. The line on a vessel indicating the maximum depth to which that vessel can sink when fully loaded with cargo. Also known as its marks.

Load on Top (LOT) - is defined as both a procedure and a practice.

> **Procedure**: Load on top is the shipboard procedure of collecting and settling water and oil mixtures, resulting from ballasting and tank cleaning operations (usually in a special slop tank or tanks), and subsequently loading cargo on top of and pumping the mixture ashore at the discharge port.
>
> **Practice**: Load on top is the act of commingling on-board quantity with cargo being loaded.

Long Ton - A unit of weight = 2,240 pounds or 1,106 kilos.

M

Marine Custody Transfer (MCT) - A custody transfer activity involving a marine tank vessel(s). Loading, discharging or lightering a ship or barge is a marine custody transfer.

Marine Surveyor - A duly qualified person who examines ships to ascertain their condition, on behalf of owners, underwriters, etc. Also called "ship surveyor" or simply "surveyor".

Maritime Law - That system of jurisprudence that prevails in courts having jurisdiction of marine causes. Also called marine or admiralty law. It is a branch of both international and commercial law.

Mean Draft - The average of the drafts measured at the bow and the stern.

Metric Ton – A unit of weight 2,204.6 pounds (1,000 kilograms).

Midship Draft - The draft read at the midship markings. This draft can, and often does, differ from the Mean Draft due to hogging or sagging.

Molded Breadth - The breadth of the hull at the widest part, measured between the outer surfaces of the frames.

Molded Depth - The depth measured between the top of the keel, or lower surface of the frame at the center line, and top of the upper deck beam at the gunwale.

N

N/B - New building.
Net Capacity - The number of tons of cargo which a vessel can carry when loaded in salt water to her summer freeboard marks. Also called cargo carrying capacity, cargo deadweight, and useful deadweight.

Net Registered Tonnage - The internal capacity of a vessel measured in units of 100 cubic feet less the space occupied by boilers, engines, shaft alleys, chain lockers, officer's and crew quarters and other spaces not available for carrying passengers or freight. Net registered tonnage is usually referred to as registered tonnage or net tonnage.

Net Tonnage - The volumetric cargo capacity of a ship expressed on the basis of 100 cubic feet to the ton. On passenger vessels it also includes space used by passengers.

Norske Veritas - Norwegian classification society.

Notice of Readiness (NOR) - Notice served by the Master to inform the terminal/charterer the vessel is ready in all respects to load or discharge cargo.

O

OBQ (On Board Quantity) - The material remaining in vessel tanks, void spaces, and/or pipelines prior to loading. On-board quantity includes water, oil, slops, oil residue, oil/water emulsions, sludge, and sediment.

OCIMF – The oil companies' international marine forum is an organization of oil companies that own or operate ships.

Outage (Ullage) - The depth of the space in a tank not occupied by oil. Same as ullage. It is measured from the flange of the ullage hole to the surface of the oil. Also the space left in a petroleum product container to allow for expansion as a result of temperature changes during shipment and use.

Outward Charter - The chartering of a vessel by an affiliate to an outside owner or non-affiliate.

Out-Turn Certificate - A document issued by the receivers of cargo indicating the amount of cargo discharged.

P

Panamax - The maximum size ship that can fit through the Panama Canal in terms of width, length and draft generally about 80,000dwt.

Passage - A journey from one port or place to another, as distinguished from the term "voyage" which refers to a ballast and loaded passage. Also sometimes called trip.

Peak Tank - Tanks in the forward and after ends of the vessel. The principal use of peak tanks is in trimming the ship.

Plating - The steel plates which form the shell or skin of the vessel.

Plimsoll Mark - The mark on the side of a classed vessel which indicates its safe load lines at varying seasonal conditions.

Port of Registry - The port at which a vessel is registered and to which she is considered to belong. The port of registry is shown on the stern below the name of the vessel.

Port State – A state that has ports to which ships call. The port state makes regulations the calling ships must adhere to. The port state control is the controlling authority of the port state on shipping such as the coast guard or naval authorities.

Portable Measurement Unit (PMU) - A device designed to measure the ship's cargo when its tanks are closed to the atmosphere. It is used in conjunction with a vapor control valve.

Portable Sampling Unit (PSU) - A device designed to sample the ship's cargo when its tanks are closed to the atmosphere. It is used in conjunction with a vapor control valve.

Pressure/Vacuum Valve (P/V Valve) - An automatic dual purpose valve, commonly fitted in the vent lines of tankers. When in the closed position, the function of this valve is to relieve either pressure or vacuum in a tank. When in the open position it allows the passage of air or vapor into and out of the tank.

Pumproom - An enclosed area on a tank vessel which houses main and stripping cargo pumps, ballast pumps, educators and the associated piping and valves necessary for their operation.

Q

Quarter - A side of a ship aft, between the main midship frames and stern. Also a side of the ship forward, between the main frames and stem.

R

Reducer- A short section of pipe, having one end of smaller diameter than the other and having a flange on each end, for connecting a smaller hose or pipe to a pipe of constant diameter.

Registry - A duty imposed on shipowners in order to secure to their vessels the privileges of ships of the nation to which they belong.

Re-Positioning - The movement of a vessel in ballast to shift it from one trading pattern to another.

Restricted Measurement System – A measurement system designed to measure the ship's cargo when its tanks are closed to the atmosphere. During measurements a minimum amount of cargo vapors might escape to the atmosphere

ROB (Remain on Board) - The material remaining in vessel tanks, void spaces, and/or pipelines after discharge. Remaining on board quantity includes water, oil, slops, oil residue, oil/water emulsions, sludge, and sediment.

Rogue Wave – An ocean wave much larger than the current wave sequence. This wave may also be outside the current wave direction and may be 100 feet or more in height

Route - See Deep Water Route, Traffic Route, Two-Way-Route. Means Whichever type is appropriate in the context unless otherwise specified.

Rules of the Road - The rules and regulations accepted by international agreement and enforced by law in marine countries which govern the movements of ships when approaching each other under such circumstances that a collision may possibly ensue.

S

Safe for Men - A term signifying that the vapor content of a space so certified is less than 0.1 on a gas indicator.

Safe for Men and Fire - A term signifying that the vapor content of a space so certified is 0.1 or less on a gas indicator and that the space contains no oil or sediment which could produce vapors.

Sag (Sagging) - The condition of a vessel caused by the unequal distribution of cargo. When a vessel loads too heavily in the center it causes a bending downward of the hull at the midships area. This can also be caused by the vessel working in heavy seas with large waves under each end and no support under the center of the ship. Sag is the opposite of Hog.

Salvage - The property which has been recovered from a wrecked vessel, or the recovery of the vessel herself.

Scupper - Any opening or tube leading through the ship's side to carry water away from the deck.

Sea Trials - A series of trials conducted by the builders during which the owner's representatives on board act in a consulting and checking capacity to determine if the vessel has met the specifications.

Seaworthiness - The sufficiency of a vessel in materials constructions, equipment, crew and outfit for the trade in which the it is employed. Any sort of disrepair to the vessel by which the cargo may suffer; overloading; untrained officers; may constitute a vessel unseaworthy.

Seaworthiness Certificate - A certificate issued by a classification society surveyor to allow a vessel proceed after she has me with a mishap that may have affected its seaworthiness. It is frequently issued to enable a vessel to proceed, after temporary repairs have been effected, to another port where permanent repairs are then carried out.

Ship's Agent - A person or firm who transacts all business in a port on behalf of shipowners or charterers. Also called shipping agent; agent.

Shipbreaker- A company that demolishes or cuts up vessels which are obsolete or unfit for sea. The steel is used for scrap.

Ship Chandler - Particular merchants handling ship's stores, supplies, and sundries, etc. Sometimes handles spare parts as accommodation to ship operators.

Shipper - The person for whom the master of a ship agrees to carry cargo. Also called consignor.

Short-Handed - Said of a vessel inadequately manned or without the regular number of men.

Short Ton – A unit of measurement equal to 2,000 pounds.

Sister Ships - Ships built on the same design.

Skin - The plating of a ship.

Slops - A mixture of petroleum and water normally arising from tank washings.

Sludge - A mixture of petroleum and water, usually semi-solid, frequently containing sand and scale.

SOLAS – Safety of Life at Sea Convention.

Special Survey - The survey requirement of a classification society that usually takes place every four years. At the special survey vital pieces of equipment are opened up and inspected by the classification surveyor.

Stem - 1 - The upright post or bar of the bow. 2 - To order or arrange for, e.g bunkers.

Suezmax – The maximize size ship that can sail through the Suez canal generally considered to be between 150-200,000 DWT depending on ships dimensions and draft.

Superstructure - Any structure built above the uppermost complete deck such as a pilothouse, bridge, accommodation house etc.

T

Tackle - Any combination of ropes and blocks that multiply power. The equipment on a vessel used to perform working tasks on the vessel.

Thieving - Determining the amount of water at the bottom of a tank of oil.

Ton – Typical unit of weight measurement used on tankers. See Long Ton, Metric Ton, Short Ton.

Tonnage – See Deadweight, GRT and NRT.

Tonne – Metric ton.

Tons Per Inch Immersion (TPI) - The number of tons required to change a vessel's draft one inch in the water. TPI varies with the draft and it's values can be found on a vessel's deadweight scale.

Topping-Off - 1) the operation of completing the loading of a tank to a required ullage. 2) Filling up cargo tanks which were only partially filled at the loading port because of port or canal draft restrictions. The filling up occurs outside the loading port via lightering activities, or at another loading port.

Track - The recommended direction or path to be followed when proceeding between pre-determined position.

Trim - The condition of a vessel with reference to it's longitudinal position in the water. It is the difference between the forward and after drafts expressed in feet/inches or meters/centimeters. Trim forward is called 'by the head' and trim aft is called 'drag'.

Trim By The Head (By The Stern) - A vessel is said to trim by the head (or stern) when its draft forward (or aft) is greater than aft (or forward).

U

Ullage - See Outage

Ullages - Measurements taken with a steel tape from the lip of the ullage hole to the to the surface of the liquid; usually read to the nearest 1/8 inch.

Underwriter- In marine insurance one who subscribes his name to the policy indicating his acceptance of the liability mentioned therein consideration for which he receives a premium.

Unseaworthiness - The states or condition of a vessel when it is not in a proper state of maintenance, or if the loading equipment or crew, or in any other respect is not ready to encounter the ordinary perils of sea.

U.S. Calls - Letter begin with "K". Liberian begin with numbers "A" or "E" or a numeral. Call letter must be used in cables after a vessel's name.

V

Vapor Control Valve (VCV) – This valves is used in conjunction with closed and restricted measurement equipment to allow measurements in ship's tanks that are closed to the atmosphere. Once a portable measurement unit (PMU) is attached to the VCV, the valve is opened and the PMU's probe is dropped into the tank to perform the required measurements.

Vapor Recovery System (VRS) - Procedures and equipment for the collection of hydrocarbon vapors from vessel's tanks and the transfer to shoreside recovery equipment.

Vessel Crossing - A vessel proceeding across a fairway/traffic lane/route.

Vessel Experience Factor (VEF) - A factor based on the compilation of the history of the total calculated volume (TCV) vessel measurements, adjusted for on-board quantity (OBQ) or remaining on board (ROB), compared with the TCV shore measurements. This factor if developed according to the latest industry standards may be used to obtain a better ship shore comparison of volumes.

Vessel Sizes and Uses. Tankers and barges come in all sizes from the small harbor/lake variety to the biggest things ever built by man that move. The size of any particular tanker depends on many factors. Use, cargo type, amount and demand, passage length and port restrictions at both loadport and the discharge port are among the most important of these. Tankers were classified in 1974 by AFRA for freight purposes as follows:

Under 16,500 DWT - Coastal, Small, Harbor/Lake Tankers
16,500 - 24,999 DWT - General Purpose Vessels
25,000 - 49,999 DWT - Medium Range Vessels
50,000 - 79,999 DWT - LR1 (Large Range 1)
80,000 - 159,999 DWT - LR2 (Large Range 2)
160,000-320,000 DWT - VLCC (Very Large Crude Carrier)
320,000 DWT & above - ULCC (Ultra Large Crude Carrier)

Coastal, Small, Harbor/Lake Tankers - Under 16,500 DWT. These small ships supply terminals with a variety of products from heating oils gasolines and kerosene, to more exotic fuels and chemicals. They are predominantly product carriers and are also are used extensively for bunkering service in harbors and busy ports.

General Purpose Vessels - 16,500 - 24,999 DWT. On a worldwide basis, this class of vessel probably covers the largest range and variety of cargoes carried. This class of ship includes chemical carriers, special service product and crude oil vessels and serve mostly coastwise terminal trades.

Medium Range Vessels - 25,000 - 49,999 DWT. Medium sized tankers cover a broad range of vessel types. Ships of this size category are capable of carrying almost any kind of petroleum product. The smaller group will usually carry gasolines, jet fuels, chemicals and heating oils. The larger size of the group will carry heavier fuel oils and crude oils.

LR1 (Large Range 1) - 50,000 - 79,999 DWT

LR2 (Large Range 2) - 80,000 - 159,999 DWT

Vessels in this class that are less than 100,000 dwt are divided into two basic categories namely, "Dirty " and "Clean". The "dirty" vessels carry the "black" or dirty cargoes such as crude oil , heavy fuel oils, asphalt etc. The "clean" vessels carry the refined "white" clean products such as gasoline, jet fuels, kerosene etc. Chemical carriers would also fall into the "clean" category. Because of the strict tank inspection requirements for clean products, most proprietary vessels or those on long term charter or do not routinely change their trading patterns from clean to dirty or vice versa. However market requirements and charter economics do require vessels to sometimes slip in and out of these clean and dirty trades. Vessels in this class that are over 100,00 dwt tend to be crude oil carriers only.

VLCC (Very Large Crude Carrier) - 160,000-320,000 DWT

ULCC (Ultra Large Crude Carrier) - 320,000 DWT and above

Because of their huge sizes these vessels have been almost exclusively only used for the carriage of crude oils. Only the smallest of this category has carried any type of refined products. Several of these ULCC classed vessels were over 500,000 and the biggest of these ships had a deadweight of 564,939 tons.

Vetting - The general process of approving a vessel for use. (From old English "To Vet" - to look at or review again.) Note: actual procedure varies from company to company.

W

Wall Wash Test - The procedure of introducing an appropriate liquid into a vessel's tank to test for hydrocarbon, color and other contaminants. This test is done by physically pouring the liquid down vessel's tank bulkheads and trapping a portion on filter paper. This test is also done on vessel's steam coils and sumps.

Watertight Door - A door so constructed that, when closed, it will prevent water under pressure from passing through.

Water/Cut Measurement - The procedure of locating the oil/water interface for the purpose of determining the volume of free water in a shore tank or vessel compartment. It is also used to refer to the line of demarcation of the oil/water interface.

Wedge Formula - A mathematical means to approximate small quantities of liquid and solid cargo and free water on board prior to loading and after discharge based on cargo compartment dimensions and vessel trim. The wedge formula is to be used only when the liquid does not touch all bulk heads of the vessel's tanks.

Wedge Table - A pre-calculated vessel table based on the wedge formula and displayed much like the vessel's usual innage/ullage tables. These tables, however, are for small quantities (on- board quantities, remaining on board) when the cargo or free water does not touch all bulkheads of the vessel tank.

Wing Tanks - Vessel tanks located to the port or starboard of the centerline and designated port or starboard wings or wing tanks.

Wipe Test - The procedure of physically wiping random interior areas and steam coils of vessel's tanks with absorbent white rags. This procedure is used to test the tank's coating for possible color contamination.

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P

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Ref: NAVSEAINST 4160.3A NAVSEA S0005-AA-GYD-030/TMMP

NAVSEA/SPAWAR TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)

INSTRUCTIONS: Continue on 8 ½" x 11" page if additional space is needed.
1. Use this report to indicate deficiencies, problems and recommendations relating to publications.
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1. PUBLICATION NUMBER	2. VOL/PART	3. REV/DATE OR CHG/DATE	4. SYSTEM/EQUIPMENT ID

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7a. Page #	7b. Para #	7c. RECOMMENDED CHANGES AND REASONS

8. ORIGINATOR'S NAME AND WORK CENTER	9. DATE	10. ORIGINATOR'S E-MAIL ADDRESS	11. TMMA of Manual (NSDSA will complete)

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TECHNICAL MANUAL TITLE	
TECHNICAL MANUAL IDENTIFICATION NUMBER	DATE
CONTRACT/TMCR NO.	

I - VALIDATION

Except as stated in II, the technical manual identified above has been satisfactorily validated in accordance with all requirements of the applicable TMCR and the approved Validation Plan. The technical manual is hereby certified to be accurate and complete, and the information, instructions, text, and illustrations conform in all respects to the applicable general and detailed specifications.

II - EXCEPTIONS

EXCEPTIONS (Brief Description and References)	AUTHORIZED BY (Government Representative Name/Code)

SIGNATURE OF CONTRACTOR'S PUBLICATIONS QUALITY ASSURANCE OFFICER	DATE